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Installation/Operation Manual

for

Model 5300

Synchro/Resolver Standard

OM-I-6006

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Installation and Operation Manual

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Resolver/Synchro Standard

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A 5300-S3456 is configured for CE conformance. The following parts have been added or changed:

1. Front panel assembly P/N 784043, which has varistors (NAI P/N 807699, GE P/N V130LA10A) from each binding post to chassis ground.

2. Varistors (NAI P/N 807699, GE P/N V130LA10A) have been added to the rear panel terminal block T1 from REF: IN+, IN- and OUT terminals to ground.

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WARNING

High Voltage exists at several points in the instrument. Normal precautions consistent with good practice should be taken to reduce shock hazard.

A potential shock hazard exists when ungrounded power source or ungrounded case operation is employed. Persons operating the instrument should be made aware of and take precautions against this condition.

North Atlantic Instruments, Inc. cannot be held responsible for damage to person or property in the process of or as a result of maintenance, calibration, or setting up of the instrument.

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CHAPTER 1
INTRODUCTION

1.1 GENERAL

This technical manual provides installation and operating instructions for the model 5300 programmable Resolver/Synchro Standard (RSS), manufactured by North Atlantic Instruments, Inc. (NAI), of Bohemia, New York. This manual is intended for personnel who install and/or operate the RSS.

1.2 SCOPE

The technical manual consists of five chapters. Chapter 1, Introduction, introduces and describes the RSS, its purpose and capabilities. Figure 1-1 shows the major assemblies of the RSS. Table 1-1 lists the RSS specifications and table 1-2 lists equipment and materials supplied with the RSS. Chapter 2, Installation, provides instructions for unpacking and inspecting the RSS prior to installation. The Installation procedures include bench mounting and mounting the RSS to a standard 19-inch equipment rack using the rack adapters provided. Repacking instructions for shipment or storage, and tables listing pin-outs for panel terminals and the IEEE-488 I/O connector are included. Setup and power turn-on procedures follow installation procedures. Chapter 3, Operation, consists of two sections. Section I describes and locates each control, switch, and indicator on the RSS. Section II describes the standard (NAI) programming language used to operate the RSS via the interface connector on the rear panel. Chapter 4, Principals of Operation, provides an overview of synchro and resolver conventions, software overview, and a system block diagram description written to support an organizational maintenance level. Chapter 5, Operator Maintenance, consists of two sections. Section I contains a list of material and procedures for performing preventive maintenance. Section II contains the performance test used to check the accuracy and function of the RSS.

1.3 INTRODUCTION

The RSS is a laboratory-grade instrument capable of simulating a synchro or resolver. As such, the RSS may be used as a standard for calibrating or testing automatic test equipment (ATE), or used to measure angle position indicators (API) and synchro-to-digital converters. The output parameters can be varied and modulated over a wide range as determined by the operator. The RSS is self-contained and can be remotely controlled by a computer via the interface connector on the rear panel. The RSS has provision for sensing its applied output at the load and comparing it to its set output. In this manner, the RSS can automatically compensate for differences due to line losses.

The RSS may also use an external reference waveform. The external inputs utilize protected autoranging technology that make connection and setup safe, easy, and efficient. The RSS outputs completely isolate the load in the event of an overload.

1.4 DESCRIPTION

The RSS is a self-contained instrument within a metal enclosure and consists of a front and rear panel assembly, system board, sine/cosine board, analog board, main power supply board, isolation power transformer, two isolation/tapped transformers, an interconnect board assembly, and two isolated power supply assemblies. The front panel houses the display/keyboard assembly, power on/off switch, and binding posts whereby synchro/resolver and external inputs and outputs may be connected. The rear panel assembly houses the power entry module, cooling fan and filter assembly, main power transformer, terminal block, calibration bridge

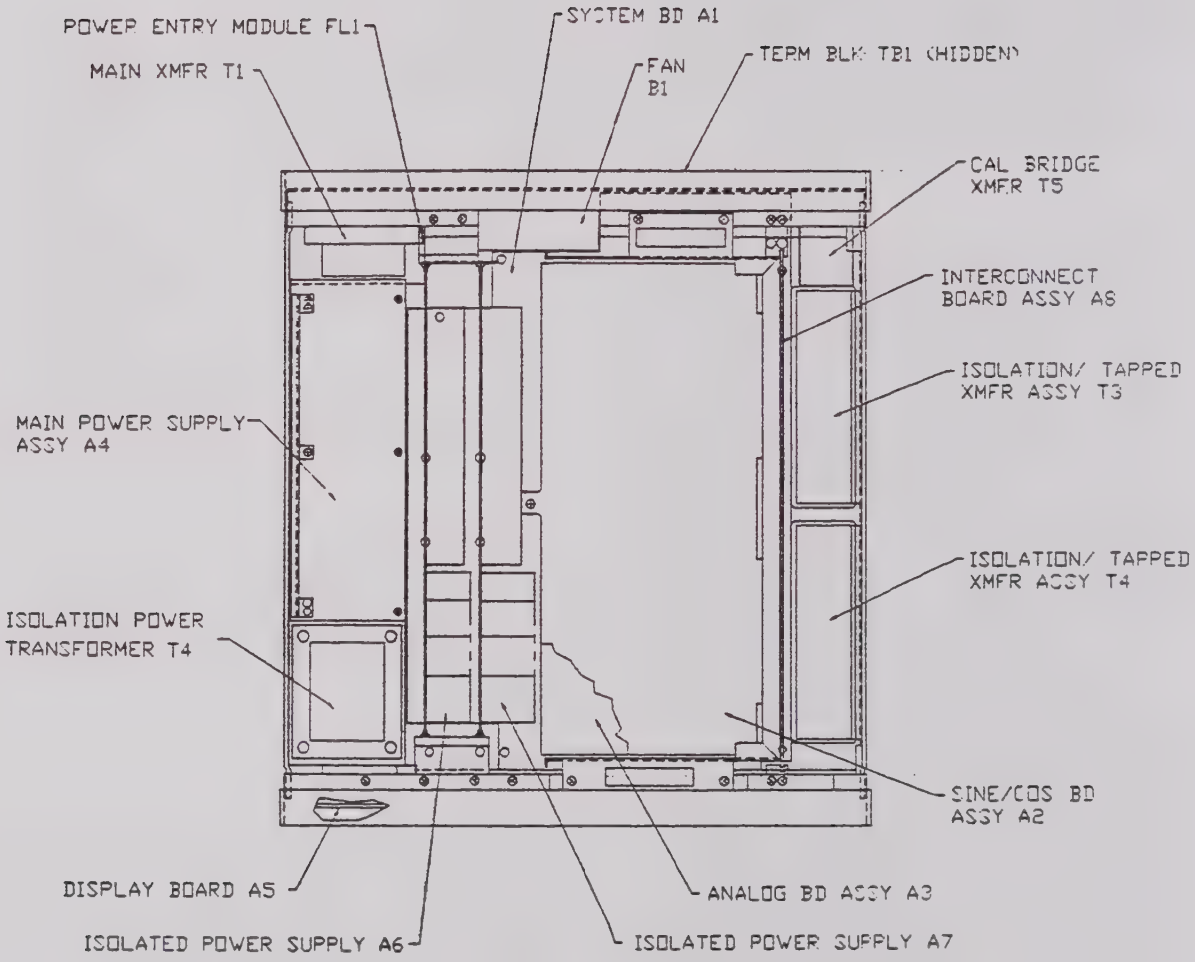


Figure 1-1. RSS Assembly Location

transformer, and IEEE-488 interface connector. Figure 1-1 locates the main assemblies of the RSS.

1.5 SAFETY

The RSS uses power that can cause physical injury or death if contacted. The following is a list of general safety precautions that should be observed when performing maintenance on the RSS. Observe all WARNINGS and CAUTIONS when they appear in this manual.

WARNING

INDICATES THAT PERSONAL INJURY OR DEATH MAY RESULT IF THE PROCEDURE IS NOT CORRECTLY FOLLOWED OR SAFETY PRECAUTIONS ARE NOT OBSERVED.

CAUTION

INDICATES THAT THE RSS MAY BE DAMAGED IF THE PROCEDURE IS NOT CORRECTLY FOLLOWED.

Observe the following general safety precautions:

WORKING ALONE

IT IS UNSAFE TO WORK ALONE. ALWAYS ENSURE THAT SOMEONE IS PRESENT TO PERFORM FIRST AID OR BE ABLE TO CALL FOR HELP SHOULD AN EMERGENCY OCCUR.

The following WARNINGS and CAUTIONS appear in the manual and are repeated here for emphasis.

WARNING

DO NOT PLUG LINE CORD INTO AC RECEPTACLE AT THIS TIME. CONNECTION TO THE INCORRECT VOLTAGE SOURCE WILL CAUSE DAMAGE TO THE RSS AND MAY CAUSE INJURY OR DEATH OF THE OPERATOR (Chapter 2, p. 1).

WARNING - DANGEROUS VOLTAGE!

TURN FRONT PANEL SWITCH OFF AND UNPLUG LINE CORD BEFORE PERFORMING THE PROCEDURES LISTED IN THIS SECTION (Chapt. 5, p. 3).

CAUTION

THIS EQUIPMENT IS SENSITIVE TO DAMAGE BY ELECTROSTATIC DISCHARGE (ESD). ALWAYS USE ESD PRECAUTIONARY PROCEDURES WHEN HANDLING EQUIPMENT (Chapt. 5, p. 3).

1.6 SPECIFICATIONS

Table 1-1 lists the specifications for the RSS.

Table 1-1. RSS Specifications

(Cont'd.)

SPECIFICATION	SYNCHRO MODE	RESOLVER MODE
Reference Input		
Operating frequency range	47 Hz to 1.2 kHz	360 Hz to 20 kHz
Voltage Range:		
47 Hz to 1.2 kHz	2 to 115 V_{RMS}	
>1.2 kHz to 20 kHz	—	2 to 26 V_{RMS}
Input impedance	200 kohms minimum	
Reference Output		
Voltage range vs Frequency:		
47 Hz to 1.2 kHz	2 to 115 V_{RMS}	
>1.2 kHz to 20 kHz	2 to 26 V_{RMS}	
Output impedance	< 0.2 ohms < 2 KHz, < 0.4 ohms < 10 KHz, < 1.0 ohm 10 KHz to 20 KHz	
Voltage Accuracy	±3 % of setting	
Voltage resolution	3 digits	
Output current:		
2 to 26 V_{RMS}	100 mA_{RMS} maximum	
>26 to 115 V_{RMS}	25 mA_{RMS} maximum	
DC Offset	5 mV maximum	
Phase shift range	0 to ±180° to 0.001° resolution	
Phase shift accuracy:		
47 to 2 kHz	±0.5°	
>2 kHz to 20 kHz	±5°	
Outputs (isolated)		
Voltage Accuracy	2% of setting	
Voltage resolution	1% of setting minimum	
DC Offset	5 mV maximum	
Voltage range (line-to-line)	1 to 90 V_{RMS}	

Table 1-1. RSS Specifications

(Cont'd.)

SPECIFICATION	SYNCHRO MODE	RESOLVER MODE
Angular accuracy vs F[a]:		
47 Hz to 360 Hz (11.8 - 90 V_{L-L})	±3 arc-sec	—
>360 Hz to 600 Hz (6 - 90 V_{L-L})	±2 arc-sec[d]	
>600 Hz to 1.2 kHz (6 - 70 V_{L-L})	±2 arc-sec[d]	±2 arc-sec[d]
>600 Hz to 1.2 kHz (70 - 90 V_{L-L})	±2 - 3 arc-sec[b]	±2 arc-sec
>1.2 kHz to 10 kHz (6 - 26 V_{L-L})	—	±2 - 15 arc-sec[b][d]
>10 kHz to 20 kHz (6 - 26 V_{L-L})	—	±15 - 60 arc-sec[b][d]
Angular Accuracy vs load (remote sensing capability):		
47 Hz to 2 kHz	±2 arc-sec/VA	±1.5 arc-sec/VA
>2 kHz to 4 kHz	—	±3 arc-sec/VA
>4 kHz to 10 kHz	—	±6 arc-sec/VA
>10 kHz to 20 kHz	—	±12 arc-sec/VA
Angular resolution	0.0001° (0.36 arc-sec)	
Angular accuracy vs temperature	±0.2 arc-sec/°C maximum	
Output drive capability[c]:		
2 to 26 V_{RMS}	4 VA maximum limited to 330 mA_{RMS} maximum	
>26 to 90 V_{RMS}	4 VA limited to 33 mA_{RMS} maximum	
Output impedance (maximum):		
47 to 2 kHz	< 0.2 ohms	
>2 kHz to 10 kHz	—	< 0.40 ohms
>10 kHz to 20 kHz	—	< 1.0 ohms
Radius (sinusoidal) accuracy	±0.005 % typical	
Dynamic angular modulation		
Continuous (CW or CCW)	To 100,000°/sec (278 rps)	
Cyclical	Sine, triangle or square wave to 1 kHz or between preset angles	
Incremental	Successive equal angles on command	

Table 1-1. RSS Specifications

(Cont'd.)

SPECIFICATION	SYNCHRO MODE	RESOLVER MODE
Other		
Front panel control	Push buttons; additional rotary control for manual angular positioning	
Remote control	IEEE-488	
Temperature	0° C to 50° C operating,-40° C to 71° C storage per MIL-T-28800E, Type III, Class 6, Style E	
Dimensions	19" (48.3 cm) W x 3.5" (8.9 cm) H x 18 7/16" (48.8 cm) D, bench or rack mounting	
Power	115/220 VAC ±10%, 47 to 440 Hz, 115 VA	

[a] Applies over the full voltage range unless otherwise indicated and includes resolution uncertainty

[b] Accuracy varies logarithmically with frequency

[c] 0° to 70° inductive load; outputs are overload and short-circuit protected

[d] Accuracy derates logaritmically from the 6-volt rating to the 1 V rating with a 50% increase in specification at 1 V

1.7 EQUIPMENT AND MATERIALS

Table 1-2 list the equipment and materials supplied with the RSS.

Table 1-3 lists the optional equipment and materials that are not supplied but required for performance testing the RSS.

Table 1-2. Equipment/Materials Supplied

DESCRIPTION	NAI MODEL/PART NUMBER
Resolver/Synchro Standard	Model 5300
Line cord	870165
Installation & Operation manual	OM-I-6006
115 V line fuse (2 A slo-blo)	800935
230 V line fuse (1 A slo-blo)	800118
Rack mounting handles (2)	210079

Table 1-3. Optional Test Equipment, Tools, and Materials Required

DESCRIPTION	MANUFACTURER/PART NUMBER*
Digital multimeter	Fluke 8506A
Oscilloscope	Tektronix 465
Oscillator	Krohn-Hite Model 4000AR
75-Watt Amplifier	Krohn-Hite Model 7500
Ratio Box	Electro Scientific Industries, Inc. - Model 73
Bridge Transformer	NAI Model TFI-0010
Digital Analyzing Voltmeter (DAV)	NAI Model 2250-F1

* Equivalent equipment is acceptable

1.8 STATEMENT OF WARRANTY

The RSS is warranted by NAI (seller) to the purchaser in accordance with the following terms and conditions.

1.8.1 LIMITED WARRANTY

The seller warrants products against defects in material and workmanship for twelve months from the date of original shipment. The seller's liability is limited to the repair or replacement of products which prove to be defective during the warranty period. There is no charge under the warranty except for transportation charges. The purchaser shall be responsible for products shipped until received by the seller.

The seller specifically excludes from the warranty 1) calibration, 2) fuses, 3) source inspection, 4) test data, 5) normal mechanical wear, e.g., end-of-life on assemblies such as switches, print heads, recording heads, etc., is dependent upon number of operations or hours of use, and end-of-life may occur within the warranty period.

The seller is not liable for consequential damage or for any injury or damage to persons or property resulting from the operation or application of products. The warranty is voided if there is evidence that products have been operated beyond their design range, improperly installed, improperly maintained, or physically mistreated. The seller reserves the right to make changes and improvements to products without any liability for incorporating such changes or improvements in any products previously sold, or for any notification to the purchaser prior to shipment. In the event the purchaser should require substantially manufactured lots to be identical to those covered by this quotation, the seller will, upon written request, provide a quotation upon a change control program.

No other warranty expressed or implied is offered by the seller other than the foregoing.

1.8.2 CLAIMS FOR DAMAGE IN SHIPMENT

The purchaser should inspect and functionally test the product(s) in accordance with the instruction manual as soon as it is received. If the product is damaged in any way, including concealed damage, a claim should be filed immediately with the carrier, or if insured separately, with the purchaser's insurance company.

1.8.3 SHIPPING

On products to be returned under warranty,

await receipt of shipping instructions then forward the instrument prepaid to the destination indicated. The original shipping containers with their appropriate blocking and isolating material is the preferred method of packing. Any other suitably strong container may be used provided the product is wrapped in a sealed plastic bag and surrounded with at least four inches of shock absorbing material to cushion firmly, preventing movement inside the container.

CHAPTER 2
INSTALLATION

2.1 GENERAL

This section describes the installation of the Model 5300 RSS Resolver/Synchro Standard (RSS).

2.2 UNPACKING AND INSPECTION

The RSS has been thoroughly tested, inspected and evaluated at the factory. Care has been taken in the design of the wrapping and packaging material to insure that no damage results from mishandling. To unpack the RSS, perform the following:

1. Remove RSS from the shipping container. Save container for future use in storing or shipping.

2. Visually check contents of the shipping container against the packing list.

3. Check for damage to RSS and notify the carrier if damage is discovered.

2.3 MECHANICAL

The RSS is designed for bench use or rack mounting. An outline and dimension drawing is shown in figure 2-1.

2.4 LINE VOLTAGE SELECTION

The RSS operates from either 115 Vrms (10%, 2 A slo-blo) or 230 Vrms (10%, 1 A slo-blo fuse), 47 Hz to 440 Hz. Each RSS is set for 115 VAC operation at the factory.

The rotary voltage selection switch is located inside the rear panel power entry module. To select the desired voltage switch position, perform the following:

WARNING

DO NOT PLUG LINE CORD INTO AC RECEPTACLE AT THIS TIME. CONNECTION TO THE INCORRECT VOLTAGE SOURCE WILL CAUSE DAMAGE TO THE RSS AND MAY CAUSE INJURY OR DEATH OF THE OPERATOR.

1. Place on/off switch to off (O) position.

2. Disconnect line cord from RSS.

3. Using a flat screwdriver blade, pry open the fuse guard cover on power entry module .

4. Rotate the selection switch until the desired voltage indicator appears.

5. Replace existing fuse with appropriate size fuse (115V = 2 A slo lo; 230V = 1 A slo-blo).

6. Close fuse guard cover and connect line cord.

2.5 FRONT PANEL TERMINALS

All front panel terminals accept double prong banana type plugs or stripped wire. Table 2-1 shows the signals available via the front panel terminals.

2.6 REAR PANEL TERMINALS

The rear panel contains connector J23 (and J22, optional) and a terminal block. J23 is used to connect to an IEEE-488 controller, and J22 (when present) allows access to the analog signals and digital angle output. The terminal block allows access to the analog signals.

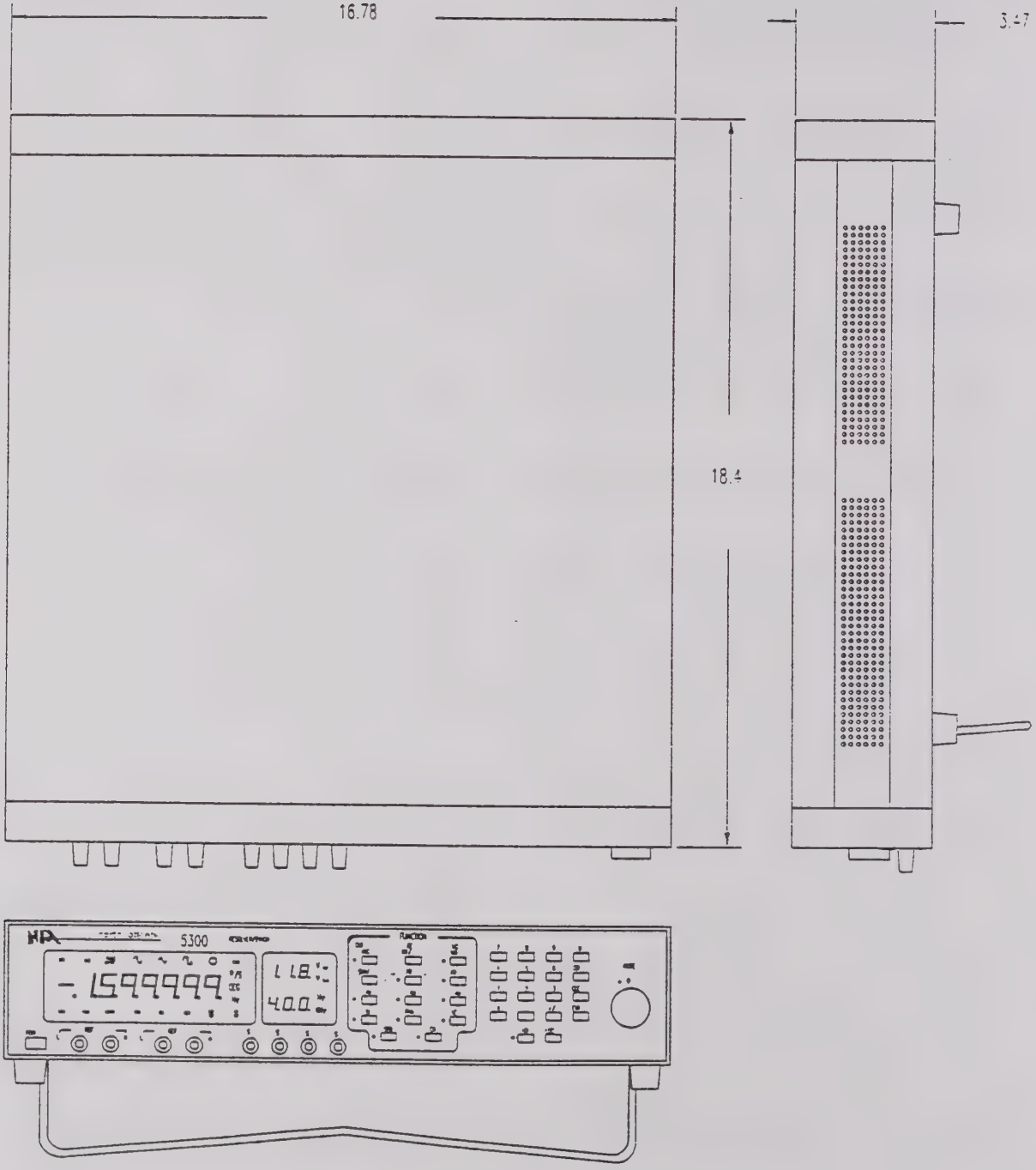


Figure 2-1. RSS Outline and Dimensions

Table 2-1. Front Panel Terminals

SIGNAL	FUNCTION
S1	Synchro/Resolver S1
S2	Synchro/Resolver S2
S3	Synchro/Resolver S3
S4	Resolver S4
REF INPUT - HI	External Reference input +
REF INPUT - LO	External Reference input -
REF OUTPUT - HI	Internal Reference output +
REF OUTPUT - LO	Internal Reference ground

Table 2-2 Terminal Block Connections

SIGNAL	FUNCTION
S1	Synchro/Resolver S1
S2	Synchro/Resolver S2
S3	Synchro/Resolver S3
S4	Resolver S4
SENSE1	Remote sense for S1
SENSE2	Remote sense for S2
SENSE3	Remote sense for S3
SENSE4	Remote sense for S4
REF IN+	External Reference input +
REF IN -	External Reference input -
REF	Internal Reference output
REF GND	Internal Reference ground
AGND	Analog Ground
CHASSIS	Chassis Ground

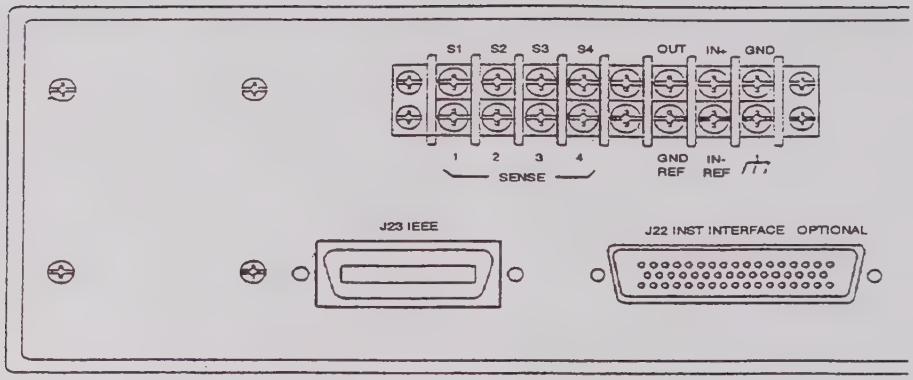


Figure 2-2. RSS Rear Panel Terminals

2.6.1 TERMINAL BLOCK

A terminal block is provided to allow access from the rear panel to the analog signals (see figure 2-2). Refer to table 2-2 for a description of the signals on the terminal block.

2.6.2 J23 IEEE-488 CABLE INSTALLATION

The IEEE-488 interface connector, J23 is used to control the RSS from an external IEEE-488 controller. Table 2-3 lists the pin designations.

To attach this connector perform the following:

1. Place power on/off switch to the off (O) position.

2. Insert 24-pin IEEE-488 interface connector into J23 rear panel connector.

3. Tighten IEEE-488 interface connector screws using a small screwdriver.

4. Connect opposite end of I/O connector to host or computer.

2.6.3 J22 INST. INTERFACE CABLE INSTALLATION (OPTIONAL)

The RSS interface cable allows access from the rear panel to the analog signals and digital angle outputs. Table 2-4 lists the pin designations.

1. Place power on/off switch to the off (O) position.

2. Insert 50-pin I/O connector into J22 rear panel connector.

3. Tighten I/O connector screws using a small screwdriver.

4. Connect opposite end of I/O connector as required.

2.7 GROUNDING

In a high accuracy RSS, it is necessary for chassis and signal (AGND) ground to be tied together. The RSS is shipped from the factory with a shorting link, on the rear panel terminal

block, making this connection.

Note

Ground loops should be avoided in system applications.

2.8 INSTALLATION

The RSS is designed for either bench or equipment rack mounting. To install the RSS, select one of the following options and perform the procedure:

2.8.1 BENCH INSTALLATION

To install the RSS on a bench, perform the following:

1. Select an appropriate area that permits access to front and rear panels of RSS. Check that air flow into RSS rear panel fan is not restricted.

2. Place RSS on bench and attach interface cables (paragraph 2.6).

3. Turn front panel on/off switch on (I) and check that RSS powers up.

4. Refer to Chapter 5, Operator Maintenance, Section II, and run performance test.

2.8.2 RACK MOUNT INSTALLATION

The RSS is shipped with two rack attachment handles to facilitate attaching the RSS to an equipment rack. To attach the handles, perform the following.

1. Remove handles and attaching hardware from shipping container.

2. Attach a handle to each side of RSS using hardware supplied.

Note

The method of mounting (slides, tray, etc.) the RSS in the rack is the responsibility of the user.

3. Place RSS in rack and attach to rack through mounting handles.

4. Attach interface cables (paragraph 2.6).

5. Turn front panel on/off switch on (I) and check that RSS powers up.

6. Refer to Chapter 5, Operator Maintenance, Section II, and run performance test.

Table 2-3. J23 IEEE-488 Interface Connector Pin Assignments

PIN	SIGNAL	PIN	SIGNAL
1	DIO1	13	DIO5
2	DIO2	14	DIO6
3	DIO3	15	DIO7
4	DIO4	16	DIO8
5	EOI	17	REN
6	DAV	18	GND (6)
7	NRFD	19	GND (7)
8	NDAC	20	GND (8)
9	IFC	21	GND (9)
10	SRQ	22	GND (10)
11	ATN	23	GND (11)
12	SHIELD	24	GND LOGIC

Table 2-4 Optional J22 Pin Designations

PIN	SIGNAL	PIN	SIGNAL
1	S1	26	
2	S3	27	BIT 2 *
3	S3 Sense	28	BIT 5 *
4	RL Out	29	BIT 8 *
5	S1 Sense	30	BIT 11 *
6	RH In	31	BIT 14 *
7	RH In	32	BIT 17 *
8	RL In	33	BIT 20 *
9		34	S2
10	BIT 1 *	35	S4
11	BIT 6 *	36	S4 Sense

Table 2-4 Optional J22 Pin Designations

PIN	SIGNAL	PIN	SIGNAL
12	BIT 7 *	37	RH Out
13	BIT 12 *	38	S2 Sense
14	BIT 13 *	39	
15	BIT 18 *	40	
16	BIT 19 *	41	
17	DGND	42	
18	S1, S3 GND	43	BIT 3 *
19	S2, S4 GND	44	BIT 4 *
20	CASE	45	BIT 9 *
21		46	BIT 10 *
22		47	BIT 15 *
23		48	BIT 16 *
24	SYNC 2 *	49	BIT 21 *
25	SYNC 1 *	50	BIT 22 *

* NOTE: These signals are optional.

CHANGE 1 (Table 2-4)

CHAPTER 3
OPERATION

SUPPLEMENTAL INFORMATION

IMPORTANT

INTERNAL MODE. After changing the internal frequency or L-L voltage (below 200 Hz) via the front panel or computer interface, wait approximately 8 seconds before initiating a calibration.

EXTERNAL MODE. After applying (or changing) an external reference signal to the REF INPUT terminals, or changing the L-L voltage below 200 Hz, wait approximately 8 seconds before initiating a calibration or measurement.

IF THIS DELAY IS NOT OBSERVED, AN ERROR MAY OCCUR.

SETTING L-L VOLTAGE AFTER AN OVERLOAD. If an overload occurs (OVLD and 0.0 V_{L-L} displayed), wait approximately 5 seconds before resetting the L-L voltage.

CHAPTER 3
OPERATION

Section I. Controls and Indicators

3.1 INTRODUCTION

This section contains general operating procedures, descriptions of controls and indicators and practical applications for the Model 5300 Resolver/Synchro Standard (RSS).

3.2 NUMERIC DISPLAYS

The RSS has three numeric displays which indicate the reference frequency, output Line-to-Line amplitude or reference amplitude, and the current shaft angle. Refer to figure 3-1 for the location of each display.

3.2.1 MAIN DISPLAY

The main display normally indicates the current shaft angle being generated. This display is also used during data entry for the following keys:

- Increment
- Phase
- Modulation Frequency
- Modulation Amplitude
- Modulation Velocity

Normally after entering data the main display will switch back to displaying the current shaft angle. If HOLD mode is active, then the main display will remain in data entry mode.

3.2.2 AMPLITUDE DISPLAY

The Amplitude display can display one of the following:

- Output Line-to-Line Amplitude
- External Reference Amplitude
- Internal Reference Amplitude

The value displayed depends on whether the RSS is in Internal or External Reference mode and whether Reference Amplitude or Output Amplitude key was selected last.

Data entry for the above is also accomplished on the Amplitude display.

3.2.3 FREQUENCY DISPLAY

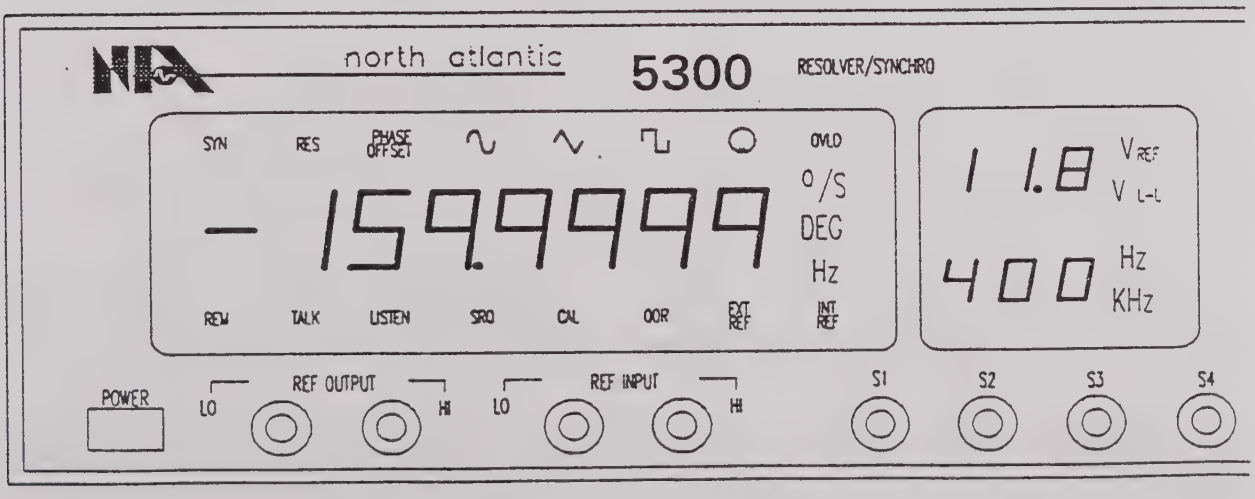
The Frequency display shows the frequency of the Internal or External reference signal. When the RSS is in External Reference mode the incoming reference signal's frequency is measured and displayed. In Internal Reference mode this display indicates the internal oscillator's programmed frequency.

3.3 INDICATORS

Indicators are located near the main display, amplitude display, frequency display and the keyboard to indicate a mode, unit or warning. Refer to figure 3-1 for the location of each indicator.

3.3.1 *SYN* INDICATOR

Figure 3-1
Front Panel Displays and Indicators



When lit, the RSS is generating 3 wire Synchro signals. S1, S2 and S3 are active. S4 is not active.

3.3.2 *RES* INDICATOR
When lit, the RSS is generating 4 wire Resolver signals. S1, S2, S3 and S4 are active.

3.3.3 *PHASE OFFSET* INDICATOR
When lit, the Synchro or Resolver output signals have a programmed phase offset from the internally generated reference signal.

3.3.4 *SINE WAVE* INDICATOR
When lit, the RSS is performing Sine Wave modulation.

3.3.5 *TRIANGLE WAVE* INDICATOR
When lit, the RSS is performing Triangle Wave modulation

3.3.6 *SQUARE WAVE* INDICATOR
When lit, the RSS is performing Square Wave modulation

3.3.7 *ROTATION* INDICATOR
When lit, the output shaft angle is rotating in a CW or CCW direction.

3.3.8 *OVERLOAD* INDICATOR
When flashing, either the reference or signal amplifiers are overloaded. When an overload is detected the amplifier outputs are disconnected and the output level is turned down to its minimum value. To reset this condition, program a new output amplitude.

3.3.9 *°/S* INDICATOR
When lit, the value in the main display is modulation velocity in degrees per second.

3.3.10 *DEG* INDICATOR
When lit, the value in the main display is the output shaft angle or phase offset in degrees.

3.3.11 *Hz* INDICATOR
When lit, the value in the main display is the modulation frequency in Hertz.

3.3.12 *INT REF* INDICATOR
When lit, the RSS is operating in Internal Reference mode.

3.3.13 *EXT REF* INDICATOR
When lit, the SRS is operating in the External Reference mode. In this mode an external reference signal must be applied to the REF INPUT terminals.

3.3.14 *OOR* INDICATOR
When lit, the RSS is operating outside of the published limits. When the OOR indicator is on, accuracy is not guaranteed.

3.3.15 *CAL* INDICATOR
This indicator lights when a Calibration is in progress.

3.3.16 *SRQ* INDICATOR
When lit, the RSS is requesting service over the IEEE 488 interface bus.

3.3.17 *LISTEN* INDICATOR
When lit, the RSS is addressed to listen over the IEEE 488 interface bus.

3.3.18 *TALK* INDICATOR
When lit, the RSS is addressed to talk over the IEEE 488 interface bus.

3.3.19 REM INDICATOR
When lit, the RSS is in remote mode. To exit remote mode hit the LOCAL pushbutton.

3.3.20 *V REF* INDICATOR
When lit, the Voltage display is showing either the Reference amplitude in volts.

3.3.21 *V L-L* INDICATOR
When lit, the Voltage display is showing the Output Line-to-Line voltage.

3.3.22 *Hz* INDICATOR
When lit, the Frequency display is indicating the Reference frequency in Hertz.

3.3.23 *KHz* INDICATOR
When lit, the Frequency display is indicating the Reference frequency in kilohertz.

3.4 KEYBOARD CONTROLS

The Keyboard controls consist of three functional groups; OUTPUT, REFERENCE and MODULATION, and a numeric keypad and other miscellaneous controls.

3.4.1 OUTPUT CONTROLS

The Output group controls the major parameters of the shaft angle generation. These controls allow the operator to set the shaft angle, select Synchro or Resolver, set the output Line-to-Line Voltage and enter Increment values. Refer to figure 3-2 for the location of each control.

3.4.1.1 *ANGLE* Switch. When the ANGLE button is pressed, the unit enters angle input mode. This mode is indicated by the LED adjacent to the ANGLE button being on.

When the ANGLE button is first hit, the last programmed angle appears in the main display. A new angle may now be entered. To enter the new angle, use the numeric keypad and follow the angle with the ENTER key.

The new angle is applied to the unit when the ENTER key or any other function key is hit. If HOLD mode is off, The ANGLE LED will go off and the new output angle will appear in the main display. To change the angle again press the ANGLE key and repeat the process again. If HOLD mode is on, it is not necessary to hit the ANGLE key for each angle change.

The output angle can also be changed with the Increment knob when the ANGLE switch led is on. Turning the Increment knob clockwise will add the programmed increment angle to the current angle for each detent. Turning the Increment knob counterclockwise will subtract the programmed from the current angle for each detent.

The UP and DOWN keys function the same as the Increment Knob. Pressing the UP Key adds the programmed increment angle to the current angle. Pressing the DOWN key subtracts the programmed increment angle from the current angle.

The output angle entry range is ± 360.0000°.

3.4.1.2 *SYN/RES* Switch. This key alternately selects a 3 wire Synchro output or a four wire Resolver output.

3.4.1.3 *AMPL* Switch. The AMPL switch is used to change the output Line-to-Line voltage.

When the AMPL button is pressed, the unit enters output amplitude input mode. This mode is indicated by the LED adjacent to the AMPL button being on.

When the AMPL button is first hit, the last programmed Line-to-Line voltage appears in the Voltage display. A new Line-to-Line voltage may now be entered. To enter the new Line-to-Line voltage, use the numeric keypad and follow the voltage with the ENTER key.

The new Line-to-Line voltage is set when the ENTER key is hit. If HOLD mode is off, The Output AMPL LED will go off and the new Output Line-to-Line voltage will appear in the voltage display. To change the Line-to-Line voltage again press the AMPL key and repeat the process again. If HOLD mode is on, it is not necessary to hit the AMPL key for each Line-to-line change.

The allowable range of the output Line-to-Line is 0 or 1 to 90V. At power-up the Line-to-Line defaults to 0V.

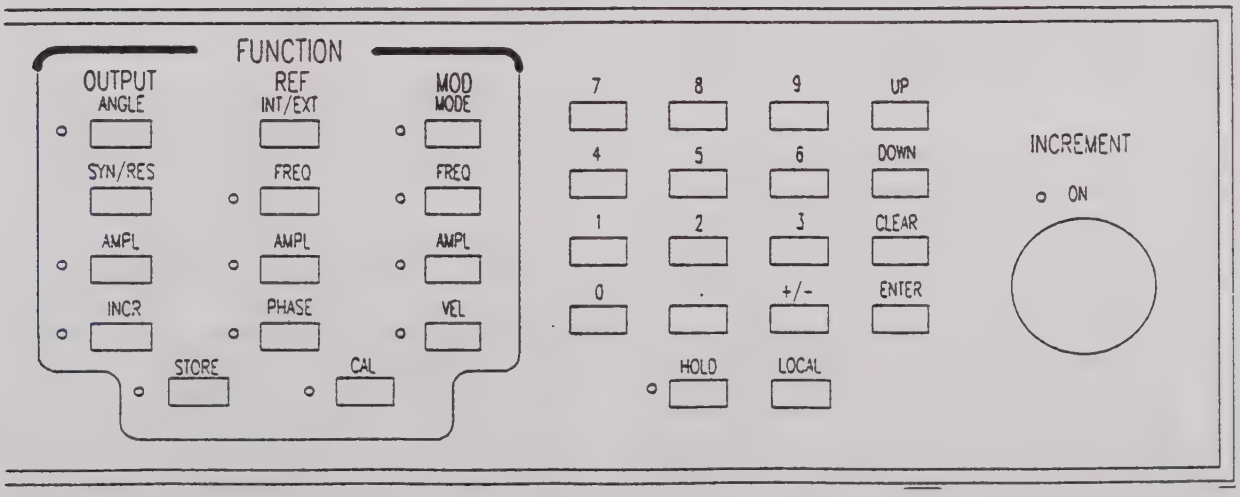
3.4.1.4 *INCR* Switch. The INCR switch is used to change the Increment variable. The increment variable is added or subtracted when the INCREMENT Knob is turned or when the UP and DOWN keys are hit. The Increment function works in the following data entry modes:

- ANGLE
- Modulation Velocity
- Modulation Frequency

Each mode has its own Increment variable. To use, press the INCR key followed by the mode (ANGLE, MOD VEL, MOD FREQ) and then the desired Increment value followed by the ENTER key. The Increment is set when the ENTER key is pressed.

When the INCR and a mode key are hit, the last programmed increment is shown on the main display. The unit is now in Increment entry mode. This mode is

Figure 3-2
Front Panel Controls



indicated by the LED adjacent to the INCR button being on.

3.4.2 REFERENCE CONTROLS

The REF group controls the Reference mode and the operating characteristics of the internal reference source.

3.4.2.1 ***INT/EXT* Switch.** This key alternately selects the signal applied to the REF INPUT terminals or the Internally generated reference as input to the simulator.

When the unit is in EXT mode the EXT REF indicator will illuminate and the REF OUTPUT terminal are disconnected.

In INT mode the INT REF indicator will light and the internal reference signal will appear at the REF OUTPUT terminals.

3.4.2.2 ***FREQ* Switch.** The FREQ switch is used to change the frequency of the internally generated reference signal. This switch only works when the instrument is in Internal reference mode.

When the FREQ button is pressed, the unit enters reference frequency input mode. This mode is indicated by the LED adjacent to the REF FREQ button being on.

When the FREQ button is first hit, the last programmed frequency appears in the Frequency display. A new frequency may now be entered. To enter the new frequency use the numeric keypad and follow the frequency with the ENTER key.

The new frequency is set when the ENTER key is hit. If HOLD mode is off, The REF FREQ LED will go off and the new frequency will appear in the frequency display. To change the frequency again press the FREQ key and repeat the process again. If HOLD mode is on, it is not necessary to hit the FREQ key for each frequency change.

The allowable range of the internal reference frequency is 47 to 20,000 Hz. At power-up the frequency defaults to 400 Hz.

3.4.2.3 ***AMPL* Switch.** The AMPL switch performs two functions depending on the current reference mode.

If the current reference mode is EXT, hitting this key displays the External reference voltage measurement in the voltage display.

When the reference mode is INT, the AMPL switch is used to change the output voltage of the internal reference.

When the AMPL button is pressed and the unit is in INT REF mode, the unit enters reference amplitude input mode. This mode is indicated by the LED adjacent to the REF AMPL button being on.

When the AMPL button is first hit and the unit is in INT REF mode, the last programmed reference voltage appears in the Voltage display. A new reference voltage may now be entered. To enter the new reference voltage, use the numeric keypad and follow the voltage with the ENTER key.

The new reference voltage is set when the ENTER key is hit. If HOLD mode is off, The REF AMPL LED will go off and the new reference voltage will appear in the voltage display. To change the reference voltage again press the AMPL key and repeat the process again. If HOLD mode is on, it is not necessary to hit the AMPL key for each reference voltage change.

The allowable range of the reference voltage is 0 or 2 to 115V. At power-up the reference voltage defaults to 0V.

3.4.2.4 ***PHASE* Switch.** The PHASE switch is used to change the phase shift between the internally generated reference signal and the Synchro or Resolver output signals. This key is active only when the unit is in INT REF mode.

When the PHASE button is pressed, the unit enters reference phase input mode. This mode is indicated by the LED adjacent to the PHASE button being on.

When the PHASE button is first hit, the last programmed Phase shift voltage appears in the main display. A new Phase shift may now be entered. To enter the new Phase shift, use the numeric keypad and follow the phase with the ENTER key.

The new Phase shift is set when the ENTER key is hit. If HOLD mode is off, The REF PHASE LED will go off and the new Phase shift voltage will appear in the main display. To change the Phase shift again press the PHASE key and repeat the process again. If HOLD mode is on, it is not necessary to hit the PHASE key for each Phase shift change.

The allowable range of the output Phase shift is ±180°. At power-up the Phase shift defaults to 0.0000°.

NOTE

When the reference mode is changed to EXT REF mode, the phase shift is set back to 0.0000°.

3.4.3 MODULATION CONTROLS

The MOD group selects the modulation mode and the modulation parameters. Four modulation modes are provided, Sine Wave, Triangle Wave, Square Wave and Continuos Rotation.

3.4.3.1 ***MODE* Switch.** This key allows the selection of the desired modulation mode. The first time the MODE key is pressed the SINE indicator light up. Repeatedly

pressing the MODE key cycles the modulation indicators in the following sequence:

SINE - TRIANGLE - SQUARE - ROTATION - OFF

To start the desired mode press ENTER when the desired mode indicator is illuminated. If ENTER is not pressed within 5 seconds the modulation mode is canceled and the unit will return to static operation.

3.4.3.2 ***FREQ*** **Switch.** The FREQ switch is used to change the frequency of the modulation.

When the FREQ button is pressed, the unit enters modulation frequency input mode. This mode is indicated by the LED adjacent to the MOD FREQ button being on.

When the FREQ button is first hit, the last programmed modulation frequency appears in the main display. A new frequency may now be entered. To enter the new frequency use the numeric keypad and follow the frequency with the ENTER key.

The new frequency is set when the ENTER key is hit. If HOLD mode is off, The MOD FREQ LED will go off and the new frequency will appear in the main display. To change the frequency again press the FREQ key and repeat the process again. If HOLD mode is on, it is not necessary to hit the FREQ key for each frequency change.

The allowable range of the modulation frequency is 0 to 1,000 Hz. At power-up the frequency defaults to 0 Hz.

The modulation frequency can also be changed with the Increment Knob or the UP and DOWN keys.

3.4.3.3 ***AMPL*** **Switch.** The AMPL switch is used to change the peak modulation amplitude in degrees.

When the AMPL button is pressed, the unit enters modulation amplitude input mode. This mode is indicated by the LED adjacent to the MOD AMPL button being on.

When the AMPL button is first hit, the last programmed modulation amplitude appears in the main display. A new modulation amplitude may now be entered. To enter the new modulation amplitude, use the numeric keypad and follow the amplitude with the ENTER key.

The new modulation amplitude is set when the ENTER key is hit. If HOLD mode is off, The MOD AMPL LED will go off and the modulation amplitude will appear in the main display. To change the modulation amplitude again press the AMPL key and repeat the process again. If HOLD mode is on, it is not necessary to hit the AMPL key for each modulation amplitude change.

The allowable range of the modulation amplitude is 0 to 180 degrees. At power-up the modulation defaults to 0°.

3.4.3.4 ***VEL*** **Switch.** The VEL switch is used to change the peak modulation Velocity in degrees/sec.

When the VEL button is pressed, the unit enters modulation Velocity input mode. This mode is indicated by the LED adjacent to the MOD VEL button being on.

When the VEL button is first hit, the last programmed modulation Velocity appears in the main display. A new modulation Velocity may now be entered. To enter the new modulation Velocity, use the numeric keypad and follow the Velocity with the ENTER key.

The new modulation Velocity is set when the ENTER key is hit. If HOLD mode is off, The MOD VEL LED will go off and the modulation Velocity will appear in the main display. To change the modulation Velocity again press the VEL key and repeat the process again. If HOLD mode is on, it is not necessary to hit the VEL key for each modulation Velocity change.

The allowable range of the modulation Velocity is 0 to 100,000 degrees/second. At power-up the modulation defaults to 0 °/sec.

3.4.4 MISCELLANEOUS CONTROLS

3.4.4.1 ***CAL*** **Switch.** This key initiates a self calibration allowing the unit to achieve it's full accuracy. A calibration should be performed anytime the frequency or the output Line-to-Line voltage changes by more than 5%.

Calibration can be performed in either Internal or External Reference mode, however when in External Mode a reference signal must be connected to the REF INPUT terminals before calibration is started

NOTE

Calibration is not permitted if an overload condition exists (OVLD and 0.0 VL-L displayed) or L-L voltage is set to zero.

When the CAL key is pressed, the CAL indicators illuminates indicating a Calibration is in progress. During Calibration the signal outputs (S1, S2, S3, and S4) are isolated. Calibration requires approximately 12 seconds to complete. When completed the CAL indicator goes off.

3.4.4.2 ***STORE*** **Switch.** This switch does not function.

3.4.4.3 ***HOLD*** **Switch.** The HOLD switch alternately turns on and off Hold mode. Hold mode is active when the HOLD LED is turned on. When the unit is not in Hold mode, the main display reverts back to displaying the current shaft angle after any data entry. When Hold mode is active, instead of the main display switching back to the shaft angle, the unit remains in data entry mode. This allows the data to changed again without having to hit the appropriate function switch.

3.4.4.4 *LOCAL* Switch. This key requests a return from IEEE 488 control to local control. If local lockout was set by the IEEE 488 controller third request will be ignored.

The REM indicator shows if the request was accepted.

3.4.4.5 *UP* Switch. This key adds a stored increment value to the displayed parameter. This key is active only in the following modes.

- Angle
- Modulation Velocity
- Modulation Frequency

3.4.4.5 *DOWN* Switch. This key subtracts a stored increment value to the displayed parameter. This key is active only in the following modes.

- Angle
- Modulation Velocity
- Modulation Frequency

3.4.4.5 *INCREMENT* Knob. This control performs the same function as the UP and DOWN keys. Turning the knob clockwise increments the parameter and turning the knob counter clockwise decrements the parameter by the stored increment value. The INCREMENT knob is active only in the following modes.

- Angle
- Modulation Velocity
- Modulation Frequency

3.4.4.6 *ENTER* Switch. This key causes keyboard numeric data to be applied to the unit.

3.4.4.7 *CLEAR* Switch. This key clears any numeric enter prior to hitting the ENTER key.

3.4.4.8 +/- Switch. This key changes the sign of the data currently being entered.

3.4.4.6 *0- 9 and .* Switch. These keys are used to enter numeric data.

3.5 SETTING UP THE REFERENCE

Before the RSS can be used the reference source must be specified. If an external reference source is to be used, connect it to the REF INPUT terminals and press

REF [INT/EXT]

one or two times until the EXT REF indicator illuminates.

If the Internal reference oscillator is to be used, three items must be programmed. First Internal reference mode must be selected. Then the frequency and output voltage must be set. Set the mode to internal reference by pressing

REF [INT/EXT]

one or two times until the INT REF indicator illuminates.

Next set the oscillators frequency. For example, to set the frequency to 1000 Hz. press the following keys:

REF [FREQ]
[1]
[0]
[0]
[0]
[ENTER]

Finally, set the reference oscillator's output voltage. For example, for 115V output , press the following keys:

REF [AMPL]
[1]
[1]
[5]
[ENTER]

3.6 PHASE SHIFTING THE OUTPUT SIGNALS

The Model RSS's phase shifting capability provides for a more accurate simulation of a real Synchro or Resolver. The output signals may be phase shifted ±180 degrees with respect to the reference. The phase shift is independent of the programmed frequency of output voltage level.

Phase shifting works only when the unit is set to Internal Reference mode.

Example: Simulate a phase lag of 7.5 degrees. Press:

REF [PHASE]
[-]
[7]
[.]
[5]

ENTER

3.7 SETTING THE LINE-TO-LINE VOLTAGE

The Line-to-Line voltage setting determines the maximum RMS voltage that will appear across the outputs. To set the output Line-to-Line voltage to 11.8 volts, press:

OUTPUT AMPL

1

1

.

8

ENTER

3.8 SETTING THE OUTPUT ANGLE

The static output shaft angle can be changed 3 different ways. Method 1 is the direct entry of the angle on the keypad. For example, set the simulator to 135.0001 degrees. Press:

OUTPUT ANGLE

1

3

5

.

0

0

0

1

ENTER

If HOLD mode is active, the ANGLE key does not have to be hit when changing the angle again.

The second method of changing the angle involves the use of the UP and DOWN keys. This method saves a lot of keystrokes if the desired angles are a fixed increment apart.

For example: If we wish to simulate the angles 0, 45, 90, 135 etc. Fist program an angle increment of 45 degrees by pressing:

OUTPUT INCR

OUTPUT ANGLE

4

5

ENTER

Next set the static angle to 0.0000 degrees

OUTPUT ANGLE

0

ENTER

The simulator is now set to 0.0000 degrees.

OUTPUT ANGLE

UP

The simulator is now set to 45.0000 degrees.

UP

The simulator is now set to 90.0000 degrees.

UP

The simulator is now set to 135.0000 degrees.

DOWN

The simulator is now set to 90.0000 degrees.

The third method is similar, first program the desired increment as above and hit the

ANGLE

key. Now rotate the increment knob. Each clockwise detent increases the angle by the increment and each counterclockwise detent decrements the angle by the programmed increment.

3.9 SINE WAVE MODULATION

When sine wave modulation is active, the output angle is sinusoidal modulated about the current static angle.

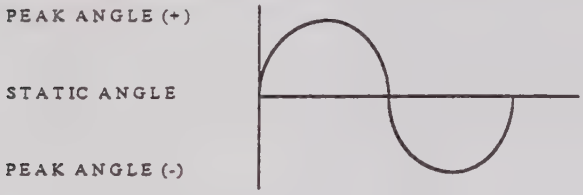


Figure 3-3. Sine Wave Modulation

The modulation characteristics are set using any two of the following parameters:

- Modulation Frequency
- Modulation Velocity
- Modulation Amplitude

These parameters can be modified dynamically while the unit is modulating. Modulation Velocity specifies the peak velocity and Modulation Amplitude specifies the peak deviation from the current angle.

The last two parameters entered determine the output waveform. These three parameters are related by the following formula:

$$A = \frac{V}{2 * \pi * F}$$

where A is the peak amplitude in degrees
V is the peak velocity in degrees/sec
F is the modulation frequency in Hz

Example: Program sine modulation at 15 Hz , 20° peak centered about 30°.

First set the static angle to 30 degrees

OUTPUT [ANGLE]

[3]

[0]

[ENTER]

Set the modulation frequency

MOD [FREQ]

[1]

[5]

[ENTER]

Set the modulation amplitude

MOD [AMPL]

[2]

[0]

[ENTER]

Finally, turn on sine modulation mode. Hit

MOD [MODE]

until the SINE indicator lights, then

[ENTER]

within 5 seconds to start sine modulation.

To turn sine wave mode off, hit

MOD [MODE]

until all modulation indicators are off , then

[ENTER]

3.10 TRIANGLE MODULATION

In triangle mode the output angle traverses back and forth between two angles at a constant velocity. The starting angle is the static angle, the angle then increases linearly to the static angle + the modulation amplitude, to the static angle - the modulation amplitude and back to the static angle.

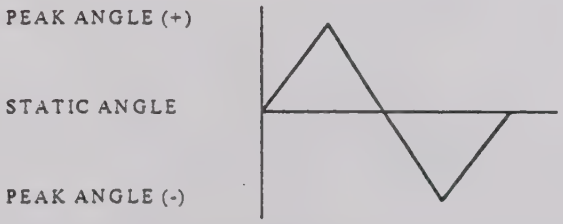


Figure 3-4. Triangle Wave Modulation

The modulation characteristics are set using any two of the following parameters:

- Modulation Frequency
- Modulation Velocity
- Modulation Amplitude

These parameters can be modified dynamically while the unit is modulating. Modulation Velocity specifies the peak velocity and Modulation Amplitude specifies the peak deviation from the current static angle.

The last two parameters entered determine the output waveform. These three parameters are related by the following formula:

$$A = \frac{V}{F}$$

where A is the peak amplitude in degrees
V is the peak velocity in degrees/sec
F is the modulation frequency in Hz

Example: Program triangle modulation at 100 °/sec , 10° peak centered about 90°.

First set the static angle to 90 degrees

OUTPUT [ANGLE]

[9]

[0]

[ENTER]

Set the modulation velocity

MOD [VEL]

[1]

[0]

[0]

[ENTER]

Set the modulation amplitude

MOD [AMPL]

[1]

[0]

[ENTER]

Finally, turn on triangle modulation mode. Hit

MOD [MODE]

until the TRIANGLE indicator lights, then

[ENTER]

within 5 seconds to start triangle modulation.

To turn triangle wave mode off, hit

MOD [MODE]

until all modulation indicators are off , then

[ENTER]

3.11 SQUARE WAVE MODULATION

In square wave mode the output angle switches back and forth between the static angle and the static angle + peak angle.

The modulation characteristics are set by specifying the following parameters:

- Modulation Frequency
- Modulation Amplitude

These parameters can be modified dynamically while the unit is modulating. Modulation Velocity specifies the peak velocity and Modulation Amplitude specifies the peak deviation from the current static angle.

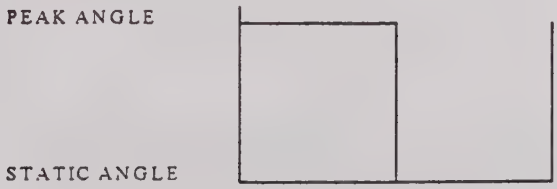


Figure 3-5. Square Wave Modulation

Example: Set the unit to square wave modulation mode, switch between 0 ° and 180 ° at a 1 Hz rate.

First set the static angle to 0.0000 degrees

OUTPUT [ANGLE]

0

ENTER

Set the modulation frequency

MOD FREQ

1

ENTER

Set the modulation amplitude

MOD AMPL

1

8

0

ENTER

Finally, turn on square wave modulation mode. Hit

MOD MODE

until the SQUARE indicator lights, then

ENTER

within 5 seconds to start sine modulation.

To turn square wave mode off, hit

MOD MODE

until all modulation indicators are off , then

ENTER

3.12 CONTINUOUS ROTATION

In Rotation mode the output angle advances Clockwise or Counter Clockwise at a constant velocity. If the velocity is specifies as positive, Counter Clockwise rotation occurs. Negative velocities cause a clockwise rotation.

Example: Program the unit to run at 1000 °/sec in a counter clockwise direction.

First set the modulation velocity

MOD VEL

1

0

0

0

ENTER

Finally, turn on rotation mode. Hit

MOD MODE

until the ROTATION indicator lights, then

ENTER

within 5 seconds to start rotation.

To turn rotation off, hit

MOD MODE

until all modulation indicators are off , then

ENTER

Section II. NAI Native Mode Programming

3.13 GENERAL

This section describes the remote operation of the Model 5300 Resolver/Synchro Standard (RSS) using the ANSI/IEEE-STD 488.1-1987, Standard Digital Interface for Programmable Instrumentation.

3.14 INTERFACE FUNCTIONS SUPPORTED

The RSS provides two-way communication (listen and talk) with the computer. The interface functions and subsets that the RSS responds to are listed in table 3-1.

Table 3-1. IEEE-488 Interface Functions and Descriptions

INTERFACE FUNCTION	SUBSET	FUNCTION
Source Handshake	SH1	Complete Capability
Acceptor Handshake	AH1	Complete Capability
Talker	T6	Basic talker with serial poll
Extended Talker	TE0	No Capability
Listener	L4	Basic Listener, Un-address if MLA
Extended Listener	LE0	No Capability
Service Request	SR0	No Capability
Remote Local	RL1	Complete Capability
Parallel Poll	PP0	No Capability
Device Clear	DC1	Complete Capability
Device Trigger	DT0	No Capability
Controller	C0	No Capability

3.15 SETTING IEEE 488-BUS ADDRESS

The device address that the RSS will respond to is set by the following sequence of front panel keystrokes:

With the RSS in local mode, press LOCAL key on front panel. The main display shows:
IEEE 6

This indicates that the current IEEE address is set to address 6. To change this to another address, press the UP key to increment the address, or press the DOWN key to decrement the address. For example, to set IEEE address 10 from address 6 previously entered, press the following key sequence:

LOCAL, UP, UP, UP, UP, ENTER

The IEEE address is stored in EEPROM when the ENTER key is pressed. Once set to the desired address, it is not necessary to set it each time the RSS is powered up.

If a mistake is made when changing the IEEE address, press the CLEAR key on the front panel to exit without modifying the address.

3.16 EXAMPLES

Programming the RSS involves issuing commands to the RSS when the RSS is in remote mode. Commands are either: Parameter Set commands, Parameter Query commands, System Query commands, Calibration command, Measurement Query commands or Test Query commands. Parameter Set commands are used to configure the RSS to operate in a particular manner, whereas Query commands direct the RSS to examine its operational mode and send a response to the computer that answers the query. Commands may be sent individually or linked to form complex commands. When commands are linked to form complex commands, they must be delimited with a semicolon. Command strings are terminated by a line feed or a carriage return line feed combination.

Commands must not conflict with a preexisting mode. An example of such a conflict is requesting an internal reference voltage when the RSS is in External Mode. Table 3-2 lists the syntax used in this section, and table 3-3 lists general command definitions.

Table 3-4 provides the command grammar and lists all commands currently available. Tables 3-5 (Parameter Set commands) and tables 3-6 through 3-10 (Query commands) describes the commands. Following are examples which illustrate how programming is accomplished.

3.16.1 VALUES

Values are entered following specific commands and may be a scientific number, decimal number, or integer.

Note

- A *crlf* is placed at the end of a command string to execute the command.
- A decimal number must contain a decimal point.

EXAMPLE	INPUT	DISPLAY
To set a SIM frequency of 15000 Hz using a scientific number, input the SIM frequency command SF followed by the scientific number for the frequency. See table 3-3 for scientific number command definition.	*SF 1.5E4 crlf*	*15.0 KHZ*

EXAMPLE	INPUT	DISPLAY
To set a SIM line-line voltage of 11.8 V, input the SIM line-to-line voltage command SLV followed by the decimal number for the voltage. See table 3-3 for decimal number command definition.	*SLV 11.8 crlf*	*11.8* $V_{L\text{-}L}$

Change 2

EXAMPLE	INPUT	DISPLAY
To set an angle of 45°, input the SIM Angle command SA followed by the integer for the angle. See table 3-3 for integer command definition.	*SA 45 crlf*	*45.0000 DEG*

3.16.2 PARAMETER SET COMMANDS

The following are several examples of how parameter set commands are programmed. The examples are representative of commands listed in table 3-5.

EXAMPLE	INPUT	DISPLAY
Reset the RSS to default values.	**RST crlf*	*SEt-UP*

EXAMPLE	INPUT	DISPLAY
Set the RSS to synchro mode.	*SS crlf*	*SYN*

The following example demonstrates how several commands and values are linked. The example follows the protocol described in table 3-4 (Command string) and uses several commands from table 3-5. This example is representative of the method used to link parameter set commands.

EXAMPLE	INPUT
Set the RSS to resolver mode, internal reference mode, output angle 45°, continuous CW rotation at a velocity of 100°/second.	*SR;SIRM;SA 45; SMV - 100; SMM CONTINUOUS crlf*

3.16.3 QUERY COMMANDS

The following are examples of how query commands are programmed. Each example is representative of the commands listed in the table referenced in the example.

EXAMPLE	INPUT	RESPONSE
Query the RSS modulation mode.	*SMM? crlf*	RSS sends the appropriate response listed in table 3-6.

EXAMPLE	INPUT	RESPONSE
Query the error status.	*SYST:ERR? crlf*	RSS sends the appropriate response listed in table 3-7.

EXAMPLE	INPUT	RESPONSE
Query calibration.	**CAL? crlf*	RSS sends the appropriate response listed in table 3-8.

EXAMPLE	INPUT	RESPONSE
Query the external reference voltage.	*SMERV? crlf*	RSS sends the appropriate response listed in table 3-9.

EXAMPLE	INPUT	RESPONSE
Query self-test.	**TST? crlf*	RSS sends the appropriate response listed in table 3-10.

EXAMPLE	INPUT	RESPONSE
Set the RSS to resolver mode, internal reference mode, output angle 45°, continuous CW rotation at a velocity of 100°/second and query the RSS that the commands were correctly executed.	*SR;SIRM;SA 45; SMV -100; SMM CONTINUOUS;SRS?;SRM?;SA?;SMV?; SMM? crlf*	RESOLVER; INTERNAL; 45.0000; -100.0000; CONTINUOUS ;

Table 3-2. Formal Syntax Notation

NOTATION	DESCRIPTION
|	Alteration, Exclusive OR
< >	The boundaries of a field of inseparable and mandatory items
[ ]	The boundaries of a field of optional items
( )	Grouping braces
::=	"Is defined to be"
...	Optional repetition of immediately preceding item or group

Table 3-3. General Command Definitions

(Cont'd.)

NOTATION	DEFINITION
Value ::=	(Scientific number | decimal number | integer)
Scientific Number ::=	[+|-][<digit>...]<dp><digit>...E<+|-><digit>[<digit>]
Decimal Number ::=	([+|-][<digit>...]<dp><digit>...] | [+|-][<digit>...)
Integer ::=	[+|-][<digit>...
Digit ::=	(0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9)
Mod Mode ::=	("CONT" | "CONTINUOUS" | "SQU" | "SQUARE" | "TRI" | "TRIANGLE" | "SINE" | "OFF")
b ::=	One or more blank space characters
dp ::=	Decimal point character (period) "."
cr :=	Carriage return character
lf :=	Line feed character

Change 2

Table 3-4. RSS NATIVE Mode Command Grammar

COMMAND	COMMAND FORMAT
Command String ::= <RSS Command>[<;><RSS Command>]... [*cr*]<*lf*>	
RSS Command ::=	(<Parameter set command> | <Parameter Query Command> | <System Query Command> | <Calibration Command> | <Measurement Query Command> | <Test Command>
Parameter Set Command ::= *See Table 3-5 for definitions*	(*RST | SS | SR | SIRM | SERM | SA<*b*><value> | SLV<*b*><value> | SRV<*b*><value> | SF<*b*><value> | SPO<*b*><value> | SMA<*b*><value> | SMV<*b*><value> | SMF<*b*><value> | SMM<*b*><mod mode>)
Parameter Query Command ::= *See Table 3-6 for definitions*	(SRS? | SRM? | SA? | SDA? | SLV? | SRV? | SF? | SPO? | SMA? | SMV? | SMF? | SMM?)
System Query Command ::= *See Table 3-7 for definitions*	(*IDN? | SYST:ERR?)
Calibration Command ::= *See Table 3-8 for definition*	(*CAL?)
Measurement Query Command ::= *See Table 3-9 for definitions*	(SMERV? | SMERF?)

Table 3-4. RSS NATIVE Mode Command Grammar

(Cont'd.)

COMMAND	COMMAND FORMAT
Test Command ::= *See Table 3-10 for definition*	(*TST?)

Table 3-5. Parameter Set Command Definitions

COMMAND	DEFINITION
*RST	Reset. All parameters set to their power-up default values
SS	SIM synchro mode
SR	SIM resolver mode
SIRM	SIM internal reference mode.
SERM	SIM external reference mode. **Note** Placing the RSS in external reference mode causes the phase offset value to be set to zero.
SA value	SIM angle. The output angle is set to the value. **Note** If the RSS is currently modulating, this command causes the modulation center angle to be dynamically modified.
SLV value	SIM line-to-line voltage. The output line-to-line voltage is set to the value. **Note** The line voltage range is $1 \leq \text{value}(V_{RMS}) \leq 90$
SRV value	SIM reference voltage. The reference voltage is set to the value. This command is valid only in internal reference mode. Attempting to set the reference voltage while in external reference mode will cause a -221 Settings Conflict error (table 5-5) to be generated. **Note** The reference voltage range is $2 \leq \text{value}(V_{RMS}) \leq 115$

Table 3-5. Parameter Set Command Definitions

(Cont'd.)

COMMAND	DEFINITION
SF value	SIM frequency. The internal reference frequency is set to the value. This command is valid only in internal reference mode. Attempting to set the frequency while in external reference mode will cause a -221 Settings Conflict error (table 5-5) to be generated. **Note** The frequency range is 47 ≤ value (Hz) ≤ 20000
SPO value	SIM phase offset. The phase offset is set to this value. This command is valid only in internal reference mode. Attempting to set the phase offset while in external reference mode will cause a -221 Settings Conflict error (table 5-5) to be generated. The phase offset value is reset to zero when the RSS is set to external reference mode. **Note** The phase offset range is -180 ≤ value (Degrees) ≤ 180
SMA value	SIM modulation amplitude. The modulation value is set to the value. **Note** The modulation amplitude range is 0 ≤ value (degrees peak-to-peak) ≤ 360
SMV value	SIM modulation velocity. The modulation velocity is set to the value. **Note** The modulation velocity range is -100000 ≤ value (degrees/second) ≤ 100000
SMF value	SIM modulation frequency. The modulation frequency is set to the value. **Note** The modulation frequency range is 0 ≤ value (Hz) ≤ 1000

Table 3-5. Parameter Set Command Definitions

(Cont'd.)

COMMAND	DEFINITION
SMM mode	SIM modulation mode. This command is used to select dynamic angle operation mode. **SINE**: The RSS is placed in sine wave modulation mode. The two most recent modulation parameter values are used to completely describe the modulating parameters. **TRIANGLE**: The RSS is placed in triangle wave modulation mode. The two most recent modulation parameter values are used to completely describe the modulating parameters. **SQUARE**: The RSS is placed in square wave modulation mode. The modulation amplitude and frequency determine the modulation characteristics. **CONTINUOUS**: The RSS is placed in continuous rotation. The velocity parameter determines the speed of rotation. Positive velocity causes CCW rotation; negative velocities cause CW rotation. **OFF**: The RSS is returned to the static angle operation mode.

Table 3-6. Parameter Query Command Definitions

COMMAND	DEFINITION
SRS?	Query SIM Resolver / Synchro Mode. The response will either be: " SYNCHRO" or " RESOLVER"
SRM?	Query SIM Reference Mode. The response will either be: " INTERNAL" or " EXTERNAL"
SA?	Query SIM Static Angle. The command returns the currently programmed static angle with 4 decimal digits of resolution. **Note** See the SDA? command to query the current dynamic angle.
SDA?	Query SIM Dynamic Angle. If the RSS is currently in dynamic operational mode, this command will return the current dynamic angle with 4 decimal digits of resolution. **Note** If the RSS is NOT currently in dynamic operational mode, this command will return the same value as the SA? query.

Table 3-6. Parameter Query Command Definitions

(Cont'd.)

COMMAND	DEFINITION
SLV?	Query SIM Line-to-Line Voltage. The response will be the current output line-to-line voltage with 3 decimal digits of resolution.
SRV?	Query SIM reference voltage. If the RSS is in internal reference mode, The response will be the current reference voltage with 3 decimal digits of resolution. If the RSS is in external reference mode, the response will be: -221,"Settings conflict " **Note** See the SMERV? Command (table 3-8) for measuring the external reference voltage.
SF?	Query SIM Frequency. If the RSS is in internal reference mode, The response will be the current reference frequency with 3 decimal digits of resolution. If the RSS is in external reference mode, the response will be: -221,"Settings conflict " **Note** See the SMERF? Command (table 3-8) for measuring the external reference frequency.
SPO?	Query SIM Phase Offset. The response will be the current phase offset value, in degrees, with 4 decimal digits of resolution.
SMA?	Query SIM Modulation Amplitude. The response will be the currently programmed modulation amplitude, regardless of the current modulation mode, with 3 decimal digits of resolution.
SMV?	Query SIM Modulation Velocity. The response will be the currently programmed modulation velocity, regardless of the current modulation mode, with 4 decimal digits of resolution.
SMF?	Query SIM Modulation Frequency. The response will be the currently programmed modulation frequency, regardless of the current modulation mode, with 3 decimal digits of resolution.
SMM?	Query SIM Modulation Mode. The response will indicate the current modulation state, and be: " OFF" or "SINE" or "SQUARE" or "TRIANGLE" or "CONTINUOUS"

Table 3-7. System Query Command Definitions

COMMAND	DEFINITION
*IDN?	Identification Query. The RSS responds with a message indicating the manufacturer, model number, and firmware version. For example: "North Atlantic,5300,0,X.X" X.X indicates firmware revision level.
SYST:ERR?	Error Status Command. The RSS responds with the next error in the error queue. Error messages contain an error number followed by a comma and an error description in quotes. The absence of error is indicated by the 0,"No error" message. 500,"Reference DSP PGM Download Error" 501,"Angle DSP PGM Download Error" 502,"Reference DSP Table Download Error" 503,"Angle DSP Table Download Error" 504,"Error Setting DSP Mode" 505,"User Disallowed from setting outputs for 15 Secs" 506,"System Bus Error" 507,"Error Setting Resolver Mode" 508,"Error Setting Synchro Mode" 509,"Error Setting Calibration Factors" 510,"Error Clearing Modulation During Calibration" 511,"Error Setting Static Angle" 512,"Error Connecting Calibration Circuits" 513,"Initial Sub Optimum Gain Error" 514,"Error Setting Calibration Gain" 515,"Error Measuring Voltage" 516,"Calibration Factor 1 Limit Error" 517,"Calibration Factor 2 Limit Error" 518,"Calibration Factor 3 Limit Error" 519,"Calibration AC Sig Error" 520,"Error Disconnecting Calibration Circuits" 521,"RAM Test Failure" 522,"ROM Test Failure" 523,"EEPROM Test Failure" 524,"Calibration Factor 4 Limit Error" 525,"DSP Angle Query Error" 526,"DSP DATA RAM Test Failure" 527,"Calibration disallowed - overload" 528,"Calibratiuon disallowed - setup" 529,"Overload condition present" 530,"Internal overload failure" 599,"Undefined Error"

Table 3-8. Calibration Command Definition

COMMAND	DEFINITION
*CAL?	Calibration Query. The RSS will perform a full calibration procedure and generate a response that indicates whether or not the RSS completed the self-calibration without any errors. The CAL enunciator is illuminated during the calibration process. After the calibration process has been completed the CAL enunciator is extinguished and the instrument is returned to its previous operational state with the new correction factors loaded into the Angle DSP. A "0" response indicates the self calibration completed without an error being detected. Any other response indicates the self calibration failed and the response message will indicate the failure. **Note** Calibration is not permitted when an overload condition exists (OVLD and 0.0 V_{L-L} displayed) or if L-L voltage is set to zero. The presence of an error during calibration is indicated by an error code being displayed on the main display, and an error message being generated. The possible error response messages are a subset of the Instrument Dependent Error Codes as defined in the error status query command.

Table 3-9. Measurement Query Command Definitions

COMMAND	DEFINITION
SMERV?	Measure External Reference Voltage. If the RSS is in external reference mode, the voltage value, in Volts RMS, of the external reference signal is returned rounded to 4 decimal places. This command is invalid in internal reference mode and will cause a -221 Settings Conflict error (table 5-5) to be returned. **Note** See the SRV? Command (table 3-6) to query the current internal mode reference voltage.

SMERF?	Measure External Reference Frequency. If the RSS is in external reference mode, the frequency value in Hz, of external reference signal is returned rounded to 2 decimal places. This command is invalid in internal reference mode and will cause a -221 Settings Conflict error (table 5-5) to be returned. **Note** See the SF? Command (table 3-6) to query the current internal mode reference frequency.

Table 3-10. Test Command Definition

COMMAND	DEFINITION
*TST?	Self Test Query. The self-test query causes an internal self-test and generates a response message indicating whether or not the RSS completed the self test without any detected errors. A "0" response indicates the self test completes without an error detected. Any other response indicates the self-test failed and the response message will indicate the failure. The possible error response messages are a subset of the Instrument Dependent Error Codes as defined in the error status query command.

Table 3-11. Service Request Command Definition

COMMAND	DEFINITION
*SRE value	Service Request Enable. This command is used to determine which instrument conditions will cause an IEEE Service Request. The value is a decimal representation of the binary bits in the Status Register that, when set, will cause a Service Request. For all bits, except bit 6, a one value indicates an enabled condition. A bit value of zero indicates a disable condition. The value for bit 6, the service request bit, will be ignored. This value is set to zero on powerup, disabling service request generation. 0 < = value < = 255
*SRE?	Service Request Enable Query. The 5300 responds with a decimal representation of the bits in the Status Register that, when set, will cause an IEEE Service Request. The value of Bit 6 will always be sent with a value of zero. The response will be in the range 0-63 or 128-191.

The status register value can be read via the IEEE serial poll. The status bit positions are defined as follows:

BIT	MEANING	BINARY REPRESENTATION	DECIMAL REPRESENTATION
0	1 = Hard Overload (Internal Hardware Failure)	0000 0001	1
1	Not Used, Always 0	0000 0010	2
2	Not Used, Always 0	0000 0100	4
3	Not Used, Always 0	0000 1000	8
4	1 = Message Available	0001 0000	16
5	1 = Soft Overload (External and Resettable)	0010 0000	32
6	1 = Service Request	0100 0000	64
7	Not Used, Always 0	1000 0000	128

*SRE Examples:

*SRE 1 - Enable Hard Overload to cause a service request. A subsequent *SRE? will return "1".

*SRE 33 - Enable Hard Overload and Soft Overload to cause a service request. A subsequent *SRE? will return "33".

*SRE 255 - Enable any allowable condition above to cause a service request. A subsequent *SRE? will return "191".

*SRE 0 - Disable service request generation. A subsequent *SRE? will return "0".

CHAPTER 4
PRINCIPLES OF OPERATION

4.1 SCOPE

This chapter contains the principles of operation for the Model 5300 Resolver/Synchro Standard (RSS). The principles are prefaced by an overview of synchro and resolver conventions.

The principles of operation for the RSS are described at the system level and based on a system block diagram showing the overall tie-in between major functional assemblies of the RSS.

The principles of operation support an organizational maintenance level wherein a RSS is tested by running the performance test (chapter 5, section II). If the RSS fails the performance test, it is assumed to be defective and repaired by removal and replacement. The defective RSS is repaired at a higher maintenance level.

4.2 SYNCHRO AND RESOLVER CONVENTIONS

Conventions for polarities, terminal designation and direction of shaft rotation for synchros and resolvers are most frequently defined in accordance with military specifications MIL-S-20708 (synchros) and MIL-R-2153 (resolvers). The RSS is provided with terminal designations and electrical characteristics to these specifications.

Note

- In applying the conventions, exercise caution that the manufacturer has followed the MIL convention.
- Check that the system use has not dictated a change in convention for a different characteristic (for example, direction reversal or angular offset).

4.2.1 SYNCHRO TRANSMITTER CONVENTIONS

$E(S1\text{-}S3) = -NE(R1\text{-}R2) \sin \theta$
$E(S3\text{-}S2) = -NE(R1\text{-}R2) \sin (\theta + 120°)$
$E(S2\text{-}S1) = -NE(R1\text{-}R2) \sin (\theta + 240°)$

Where E(S1-S3) is the stator voltage S1 with respect to S3. Other stator and rotor voltages are similarly defined. N is the ratio of the maximum voltage across a pair of stator terminals to the voltage across the rotor terminals. θ is the shaft angle displacement from electrical zero which satisfies these equations. A schematic of the synchro transmitter is shown in figure 4-1.

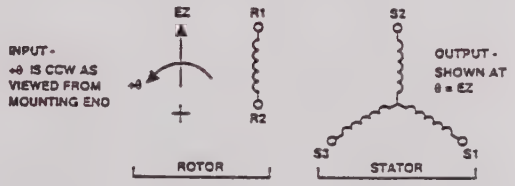


Figure 4-1. Synchro Transmitter, Schematic

4.2.2 RESOLVER TRANSMITTER CONVENTIONS

For rotor energized resolvers, the following equations apply:

$E(S1\text{-}S3) = -NE(R1\text{-}R3)\cos \theta - NE(R2\text{-}R4)\sin \theta$
$E(S2\text{-}S4) = -NE(R2\text{-}R4)\cos \theta - NE(R1\text{-}R3)\sin \theta$

A rotor energized resolver transmitter schematic

is shown in figure 4-2. Input and output may be reversed for stator energized devices.

Because the NAI standard assumes an R2R4 energized resolver, the resolver outputs become:

$E(S1\text{-}S3) = -NE(R2\text{-}R4)\sin\theta$
$E(S2\text{-}S4) = +NE(R2\text{-}R4)\cos\theta$

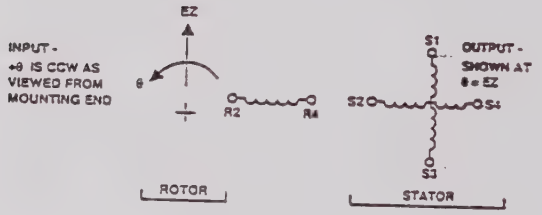


Figure 4-2. Resolver Transmitter, Schematic

4.3 SYSTEM LEVEL PRINCIPLES OF OPERATION

The RSS system block diagram is shown in figure 4-3. The RSS consists of five major functional assemblies; the analog board, the sine/cosine board, the system board, the display/keyboard assembly, and the power supply system. These functional assemblies and an overview of the software are described in the following paragraphs.

4.3.1 ANALOG BOARD

The analog board generates a precise reference waveform that drives isolation/tapped transformers T3 and T4 for the sine and cosine channels of the sine/cosine board. The analog board also provides an externally generated reference output to jacks on the front panel and terminals on the rear panel terminal block whereby a reference voltage may be applied to simulate the rotor of a synchro or resolver.

The input to the analog board may be from an external source, in which case the internal reference circuits are not selected. The external reference is precisely level adjusted with the (protected) autoranging and AGC circuits. Control of the analog board is provided by the system board. The analog board also contains the measurement circuits, fine level and electrical phase control circuits, and the calibration circuits.

4.3.2 SINE/COSINE BOARD

The sine/cosine board consists of two similar (but isolated) channels enabled by the analog board to provide precise, low impedance outputs to simulate the stator windings of a synchro or resolver. Precision, 21-bit resolution, for the dynamic rotational angles for each channel is achieved with fast-switched transformers/MUX circuits and an MDAC circuit. The tapped transformer/MUX circuit provides the upper four most significant bits (MSB), the MDAC circuits provide the lower 16-bits, and the isolation transformer/MUX circuit provides the sign bit. The isolation transformer/MUX circuit feeds the tapped transformer which subsequently feeds the MDAC circuit. The combination of outputs from the tapped transformer/MUX circuit and the MDAC circuit are summed and provide the input for a power amplifier. The outputs for the power amplifier are accessible from front panel jacks and the rear panel terminal block. The sine/cosine board is controlled by the system board.

4.3.3 SYSTEM BOARD

The system board provides microprocessor control over all functions of the RSS. Programmed by firmware residing in an Erasable Programmable Read Only Memory (EPROM), the system board drives the display board and samples the keyboard assembly, performs digital signal processing to compute angle and reference data, samples IEEE-488 connector J23 on the rear panel, and provides

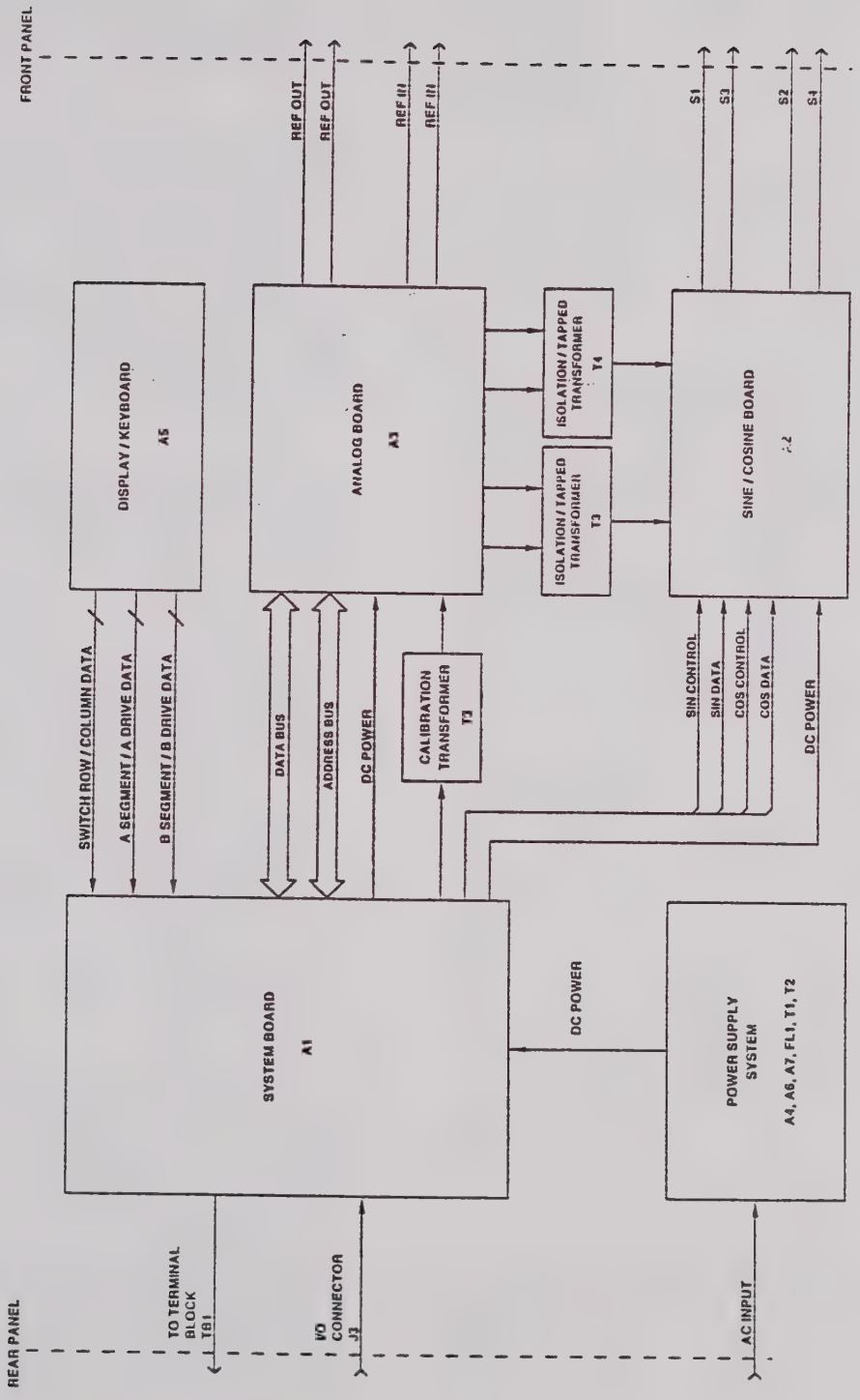


Figure 4-3. System Block Diagram

handshaking with an external computer during remote operation. The system board functions as a distribution bus for all dc power supplies, and as a mother board for the interconnect board. The interconnect board functions as a daughter board for the analog and sine/cosine boards mounted in the card file.

4.3.4 DISPLAY/KEYBOARD ASSEMBLY

The display/keyboard assembly consists of a Light Emitting Diode (LED) display and a keyboard assembly. The display indicates operating conditions of the RSS, and the keyboard provides the operator with a means of entering data into the RSS. The display consists of two panels; a primary 8-digit numerical panel with 19 LED indicators (SYN, RES, PHASE OFFSET, Sine wave symbol, Triangle wave symbol, Square wave symbol, Rotational symbol, OVLD, °/S, DEG, Hz, INT REF, EXT REF, OOR, CAL, SRQ, LISTEN, TALK, and REM) and a secondary numerical panel displaying 3-digit voltage and frequency with four LED indicators (V_{REF}, V_{L-L}, Hz, and KHz).

The keyboard assembly contains 20 push button switches, a 12-key (see following note) numeric pad (digits 0 through 9, ±, and decimal point), and an optical encoder.

Note

The front panel STORE push button switch, if installed, does not function.

4.3.5 POWER SUPPLY SYSTEM

The power supply system consists of a main power supply board and two, identical, isolated power supply assemblies.

4.3.5.1 Main Power Supply Board. The main power supply board receives AC input from main transformer T1 and performs rectification, filtering, and regulation to provide continuous +5 Vdc and ±15 Vdc power to the system board and analog board.

Note

The system board acts as a distribution bus for all dc power.

The main power supply board also provides, after a turn-on delay, ±48 Vdc and ±175 Vdc to the RSS circuits. These outputs are switched from the RSS system by relays. The main power supply board has a hi-voltage overload sense circuit that detects reference output overloads and subsequently relay isolates all outputs upon overload. The main power supply board switches ac power to the isolated power transformer via a relay.

4.3.5.2 Isolated Power Supply. The isolated power supplies are identical and provide separate ±15 Vdc, ±20 Vdc, ±48 Vdc, and ±150 Vdc to each channel of the sine/cosine board. Similar to the main power supply board, each isolated power supply has a hi-voltage overload sense circuit that detects simulator output S1 through S4 overloads and isolates all the outputs. The main power supply board is attached to the chassis, whereas the isolated power supplies plug into connectors on the system board. The isolated power supplies are identical and may be used in either connector location.

4.3.6 SOFTWARE OVERVIEW

This overview describes the two major sections of the software; the Startup Code and the Operational Code.

4.3.6.1 STARTUP CODE. The startup code is responsible for determining operability of the basic hardware components, initializing the hardware, and starting the operating system. When the RSS is turned on, the startup code causes the RSS signals to be isolated, runs the power-up tests to test the display, CPU, RAM, ROM, EEPROM, and two digital signal processors (DSP). If the power-up test detects an error, an error message is displayed, if possible, and processing is halted.

Assuming that an error has not occurred, the startup code next initializes the system stack and heap, programmable timer, keyboard and remote interface hardware, main display, voltage display and frequency displays.

The RSS is then set to its default values, the signals are connected, and the main loop is entered.

4.3.6.2 **OPERATIONAL CODE**. The operational code is a system of tasks that are run in a real-time, multitasking environment. These tasks are the timer, overload handler, keystroke processor, remote interrupt processor, and the main loop.

The timer task is a synchronous task that runs in response to the programmable timer interrupt. This task handles interprocess synchronization and the main system coordination.

The overload handler task is a high priority asynchronous task that runs in response to a RSS detected overload condition. The handler turns down and isolates the output to prevent harm to the RSS and possible injury to the operator.

The keystroke processor is an asynchronous task that runs in response to a key being depressed. The handler debounces the key, and decodes and buffers the keystroke. Keystroke buffer status is tracked by the operating system.

The remote interrupt processor is an asynchronous task that runs in response to a remote command or a status change at the IEEE-488 interface. The remote command processor buffers incoming command characters, sends outgoing message characters, and informs the operating system of remote status changes.

The main loop is a background task that monitors the status of the keystroke buffer and remote processor buffer. If a remote command has been buffered, the command processor is called. If a keystroke has been buffered, the keystroke processor is called. The main loop also coordinates the measurement and display of the reference voltage and frequency, and auto-ranging when the RSS is operating in external reference mode. The keystroke processor interprets local inputs using lower level data input routines, and calls the appropriate RSS interface routines. If the interface routine returns an error status, the error number is posted on the main display of the RSS.

The remote interpreter interprets commands and returns status via the IEEE-488 interface. As the syntax is checked and parameters are converted, an error message is queued if an invalid command is detected. The error message is returned on the next error query command. When a valid command is parsed, the RSS routine is called with the input parameters. If the interface routine returns an error status, an error message is queued and returned for the next error query command. In the case of a query command, the RSS interface routine is called to obtain the RSS setting returned by the IEEE-488 interface.

The RSS interface routines provide a common interface to the remote command and keystroke processors and are used to set or query RSS parameters. Parameters are tested for limit errors and settings conflicts.

The lower level instrument drivers and DSP interface routines are called to carry out the intended process. These routines return an integer value that indicates success or failure status.

Note

The instrument drivers are at the lowest level and handle the details of writing values to the RSS registers.

CHAPTER 5
OPERATOR MAINTENANCE

5.1 GENERAL

This chapter contains maintenance procedures for the Resolver/Synchro Standard (RSS) and consists of two sections. Section I contains the schedule and preventive maintenance procedures for the RSS. Section II contains the performance test whereby the overall operation of the RSS can be verified.

5.2 EQUIPMENT/MATERIALS REQUIRED

Table 5-1 lists the equipment and materials required to perform the maintenance procedures in this chapter.

Table 5-1. Equipment/Materials Required for Maintenance

EQUIPMENT/MATERIALS *	MODEL/PART NO.	PARAGRAPH NO.
Sash brush	-	5.5.1, 5.5.2
Lint-free cloth	-	5.5.1, 5.5.2
Mild detergent	-	5.5.1, 5.5.2
Shop vacuum cleaner	-	5.5.2
Oscillator	Krohn-Hite Model 4000AR	5.7.1, 5.7.2
75-Watt Amplifier	Krohn-Hite Model 7500	5.7.1, 5.7.2
Ratio Box (Optional - See table 5-3, part 3).	Electro Scientific Industries, Inc. - Model 73 with 2.5 V/Hz option.	5.7.1
Bridge Transformer	NAI Model TFI-0010	5.7.1
Digital analyzing voltmeter (DAV)	NAI - Model 2250	5.7.1, 5.7.2
Oscilloscope	Tektronix - Model 465	5.7.1, 5.7.2
Thermal RMS Digital multimeter	Fluke - Model 8506A	5.7.1, 5.7.2

* Equivalent material and equipment is acceptable

5.3 SCOPE OF SECTION I

This section describes the preventive maintenance (PM) procedures for the RSS.

5.4 SCHEDULE

Table 5-2 lists the schedule to perform PM.

5.5 CLEANING

Cleaning procedures consist of general cleaning of the external surfaces of the RSS including the Display panel. Specific cleaning consists of cleaning the filter element in the fan assembly and any dust accumulated within the RSS.

5.5.1 GENERAL CLEANING

Perform general cleaning as follows:

1. Remove dust on exterior surfaces of RSS with a dry, lint-free cloth. To remove stubborn areas, clean with water and mild detergent.

2. Clean the display panels with a clean cloth moistened with water.

5.5.2 SPECIFIC CLEANING

The filter element of the fan assembly should be cleaned every 500 operating hours (minimum). To accomplish specific cleaning, perform the following:

WARNING

TURN FRONT PANEL SWITCH OFF AND UNPLUG LINE CORD BEFORE PERFORMING THE PROCEDURES LISTED IN THIS SECTION.

CAUTION

THIS EQUIPMENT IS SENSITIVE TO DAMAGE BY ELECTROSTATIC DISCHARGE (ESD). ALWAYS USE ESD PRECAUTIONARY PROCEDURES WHEN HANDLING EQUIPMENT.

1. Turn power switch off and disconnect power cable.

2. Remove six screws securing top cover to sides of chassis and remove cover.

3. Remove six screws securing bottom cover to sides of chassis and remove cover.

4. With covers removed, inspect cleanliness of internal components. If cleaning is required, brush dust into vacuum cleaner nozzle with sash brush or wipe with clean cloth.

5. Vacuum filter element retainer of fan assembly using shop vacuum cleaner.

6. Remove fan, filter bracket, and filter element from rear panel by removing four screws and nuts.

7. Wash filter element in solution of water and mild detergent. Rinse filter element in clean water and allow to dry before installation.

8. Install filter element.

9. Secure fan, filter bracket, and filter to rear panel with four screws and nuts.

10. Secure bottom cover to sides of chassis with six screws.

11. Secure top cover to sides of chassis with six screws.

12. Connect power cable.

Table 5-2. PM Schedule

PM ACTION	SCHEDULE
General Cleaning (Paragraph 5.5.1)	Monthly
Specific Cleaning (Paragraph 5.5.2)	Every 500 operating hours or as required
Performance test (Paragraph 5.7)	Annually

Section II. Performance Test

5.6 SCOPE OF SECTION II

This section provides the performance test for the RSS and consists of four parts. Part one involves turning the RSS on and observing specific actions that the RSS performs during power-up, operator inputs to verify operation of the display/keyboard assembly, and a check of the interface circuitry. Part two checks that the RSS is functioning properly. Part three uses a ratio box to test the accuracy of the RSS. Part four provides procedures to test the accuracy of the RSS if a ratio box is not available. The performance test shall be performed as scheduled (table 5-2) or whenever the performance or accuracy of the RSS is questionable.

Note

If the performance test fails or cannot be run, the RSS must be checked at a higher level of maintenance to determine the problem. After the problem is corrected, run the performance test again from the beginning.

5.7 PERFORMANCE TESTING

5.7.1 PERFORMANCE TEST PROCEDURE

Figure 5-1 is a flow chart that shows how the performance test is organized. To run the performance test, see tables 5-1 and 5-3 and perform the following:

Table 5-3. Performance Test

ACTION	MAIN DISPLAY	VOLTAGE DISPLAY	NOTES
Part 1. Power-Up Test			
1. Connect power cable and IEEE interface cable to RSS.	-	-	-
2. Turn power switch on (I). Observe that each display panel and keyboard function LED is on, and that main display and voltage display sequence is as shown.			
	N.NN		This is the version of the system board EPROM
	111111.11	*11.1*	
	22222.222	*2.22*	
	3333.3333	*33.3*	
	444.44444	*4.44*	

Table 5-3. Performance Test

(Cont'd.)

ACTION	MAIN DISPLAY	VOLTAGE DISPLAY	NOTES
	55.555555	*55.5*	
	6.6666666	*6.66*	
	77.777777	*77.7*	
	888.88888	*8.88*	
	9999.9999	*99.9*	
3. Observe that all function LED's are off.	*00000.000*	*0.00*	
4. Observe that main display INT REF indicator is on. Main display as shown.	*SEt-UP* *INT REF*		
5. Observe that main display RES and INT REF indicators are on. Main display as shown.	*RES* *SEt-UP* *INT REF*		
6. Observe that main display RES and INT REF indicators are on. Main and voltage displays as shown.	*RES* *0.0000 DEG* *INT REF*	*0.00 V_{REF}* *400 Hz*	

Note

- **The following tests check the function of each push button**
- **Display data are shown as italic characters.**
- **Press push buttons in order listed.**

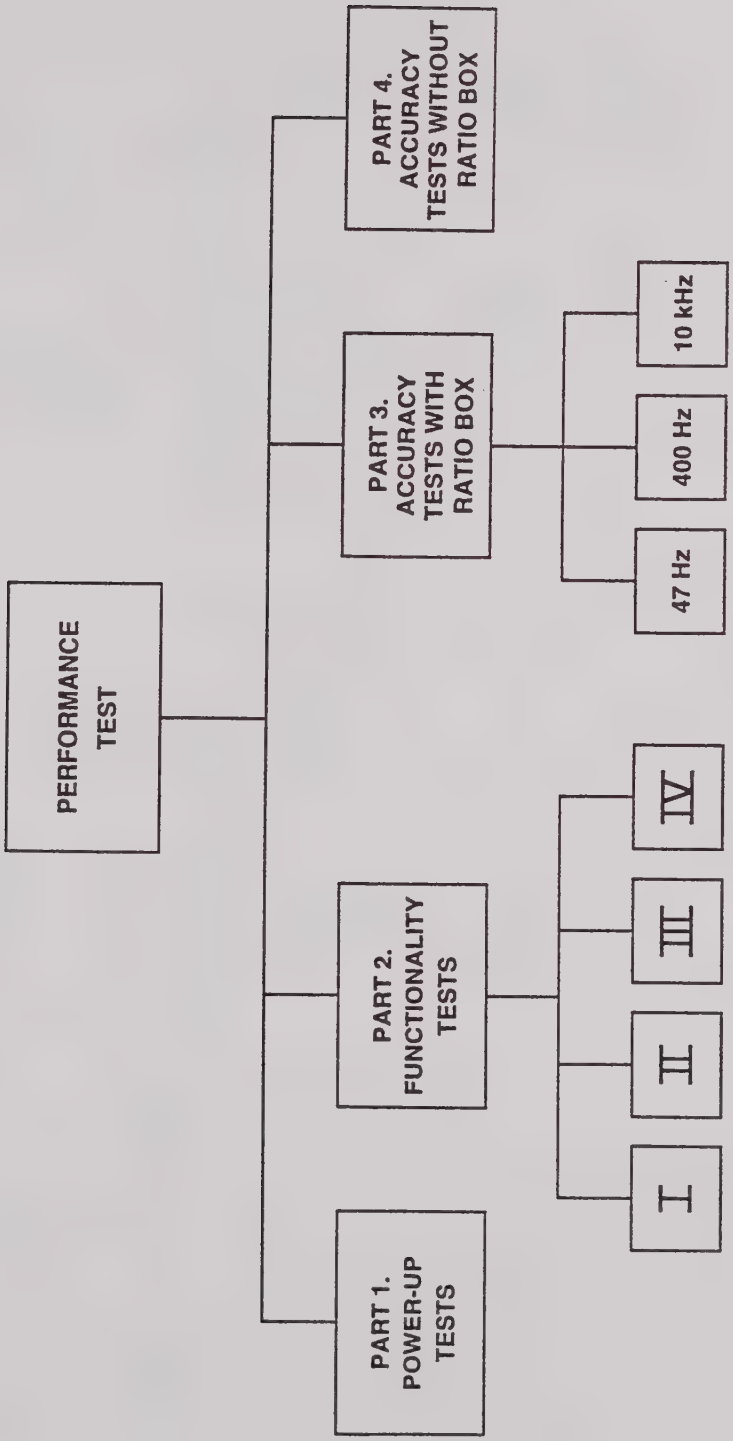


Figure 5-1. Performance Test Flow Chart (Sheet 1 of 2)

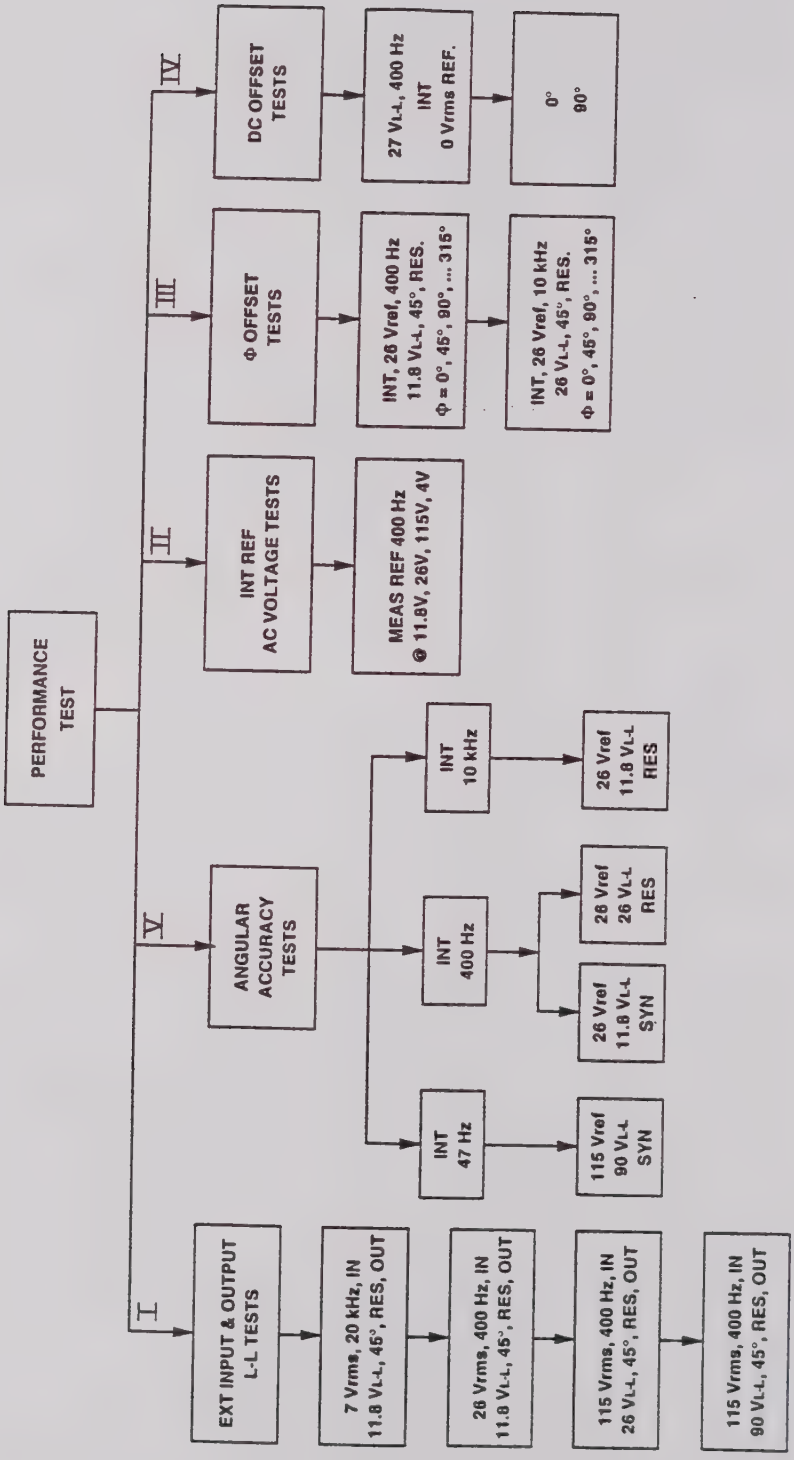

PERFORMANCE TEST
I
EXT INPUT & OUTPUT L-L TESTS
7 Vrms, 20 kHz, IN 11.8 VL-L, 45°, RES, OUT
26 Vrms, 400 Hz, IN 11.8 VL-L, 45°, RES, OUT
115 Vrms, 400 Hz, IN 26 VL-L, 45°, RES, OUT
115 Vrms, 400 Hz, IN 90 VL-L, 45°, RES, OUT
II
INT REF AC VOLTAGE TESTS
MEAS REF 400 Hz @ 11.8V, 26V, 115V, 4V
III
Φ OFFSET TESTS
INT, 26 Vref, 400 Hz 11.8 VL-L, 45°, RES. Φ = 0°, 45°, 90°, ... 315°
INT, 26 Vref, 10 kHz 26 VL-L, 45°, RES. Φ = 0°, 45°, 90°, ... 315°
IV
DC OFFSET TESTS
27 VL-L, 400 Hz INT 0 Vrms REF.
0°
90°
V
ANGULAR ACCURACY TESTS
INT 47 Hz
115 Vref 90 VL-L SYN
INT 400 Hz
26 Vref 11.8 VL-L SYN
26 Vref 26 VL-L RES
INT 10 kHz
26 Vref 11.8 VL-L RES

Figure 5-1. Performance Test Flow Chart (Sheet 2 of 2)

Table 5-3. Performance Test

(Cont'd.)

ACTION	MAIN DISPLAY	VOLTAGE DISPLAY	NOTES
7. Press OUTPUT ANGLE push button.	*RES* *0.0000 DEG* *INT* *REF*	*0.00 V_{REF}* *400 Hz*	OUTPUT ANGLE push button LED and INCREMENT knob LED on.
8. Rotate INCREMENT knob CW and CCW.	For CW rotation, observe that the display changes one (1) positive increment for each increment of the INCREMENT knob. For CCW rotation, observe that the display changes one (1) negative increment for each increment of the INCREMENT knob.	*0.00 V_{REF}* *400 Hz*	
9. Press UP push button.	Observe that the display increases one (1) positive increment.	No Change	
10. Press DOWN push button. Leave setting at 0.0000.	Observe that the display decreases one (1) negative increment.	No Change	
11. Press 1 2 . 3 4 5 6 7 push buttons.	*RES* *12.34567 DEG* *INT* *REF*		
12. Press CLEAR push button.	*RES* *0.0000 DEG* *INT* *REF*	No Change	

Table 5-3. Performance Test

(Cont'd.)

ACTION	MAIN DISPLAY	VOLTAGE DISPLAY	NOTES
13. Press 1 2 . 3 4 8 9 0 push buttons.	*RES* *12.34890 DEG* *INT* *REF*	No Change	
14. Press +/- push button.	*RES* *-12.34890 DEG* *INT* *REF*	*0.00 V_{REF}* *400 Hz*	
15. Press CLEAR push button.	*RES* *0.0000 DEG* *INT* *REF*	No Change	
16. Press 1 2 . 3 4 5 6 7 and ENTER push buttons.	*RES* *12.3457 DEG* *INT* *REF*	No Change	OUTPUT ANGLE push button LED and INCREMENT LED off.
17. Press OUTPUT SYN/RES push button.	*SYN* *12.3457 DEG* *INT* *REF*	No Change	OUTPUT AMPL LED off
18. Press REF INT/EXT push button.	*SYN* *12.3457 DEG* *EXT* *REF*	*0.00 V_{REF}* *0.00 Hz*	*SEt-UP* is momentarily displayed in main display.

Table 5-3. Performance Test

(Cont'd.)

ACTION	MAIN DISPLAY	VOLTAGE DISPLAY	NOTES
19. Press REF INT/EXT push button.	*SYN* *12.3457 DEG* *INT* *REF*	*0.00 V_{REF}* *400 Hz*	*SEt-UP* is momentarily displayed in main display.
20. Press REF FREQ push button	No Change	No Change	FREQ push button LED on.
21. Press REF AMPL push button.	No Change	*0.00 V_{REF}* *400 Hz*	REF AMPL push button LED on.
22. Press REF PHASE push button.	*SYN* *0.0000 DEG* *INT* *REF*	No Change	PHASE push button LED on.
23. Press MOD MODE push button repeatedly.	Observe that Sine, Triangle, Square, and Rotational indicators sequentially light.	No Change	MODE LED turns off approximately five seconds after last position selected
24. Press MOD FREQ push button.	*SYN* *0.0000 Hz* *INT* *REF*	No Change	MOD FREQ LED on.
25. Press MOD AMPL push button.	*SYN* *0.0000 DEG* *INT* *REF*	No Change	MOD AMPL LED on.

Table 5-3. Performance Test

(Cont'd.)

ACTION	MAIN DISPLAY	VOLTAGE DISPLAY	NOTES
26. Press MOD VEL push button.	*SYN* *0.0000 °/SEC* *INT* *REF*	No Change	MOD VEL LED on.
27. Press MOD MODE push button.	*SYN* *12.3457 DEG* *INT* *REF*	*0.00 V_{REF}* *400 Hz*	Wait for MOD MODE push button LED to go off before proceeding to next step.
28. Press LOCAL push button.	*IEEE 6*	No Change	
29. Press UP push button repeatedly to display IEEE addresses 0 through 31. Leave setting at 6.	*IEEE 0* through *IEEE 31*	No Change	
30. Press ENTER push button.			
31. Set IEEE address to 6 on computer.			
32. Press CLEAR push button.	*SYN* *12.3457 DEG* *INT* *REF*		
33. Send *RST command to RSS from computer.	*RES* **0.0000 DEG** **REM** **INT** **REF**	*0.0 V_{L-L}* *400 Hz*	*SEt-UP* is displayed in main display for a few seconds. LISTEN flashes momentarily.

Table 5-3. Performance Test

(Cont'd.)

ACTION	MAIN DISPLAY	VOLTAGE DISPLAY	NOTES
Part 2. Functionality Tests			
1. With RSS and test equipment power off, see figure 5-2 and connect test equipment as shown. 2. Turn test equipment outputs down and turn power on. Allow test equipment to warm-up for 15 minutes.			
3. Turn RSS power on and set RSS to 4 V_{L-L}, 45°, RES, EXT REF.	*RES* *45.0000 DEG* *EXT REF*	*4 V_{L-L}* *0.00 HZ*	
4. Adjust output of oscillator and power amplifier for 7 V_{RMS}, 20 KHZ.		*4 V_{L-L}* *20 KHZ*	
5. Connect oscilloscope and RMS multimeter to RSS terminals S1 (LO) and S3 (HI). 6. Check for sine wave and that multimeter reading is between 2.7718 and 2.8850. 7. Connect oscilloscope and multimeter to RSS terminals S4 (LO) and S2 (HI) and check for sine wave and that multimeter reading is between 2.7718 and 2.8850.			
8. Adjust output of oscillator and power amplifier for 26 V_{RMS}, 400 HZ.		*4 V_{L-L}* *400 HZ*	
9. Set RSS to 11.8 V_{L-L}.	*RES* *45.0000 DEG* *EXT REF*	*11.8 V_{L-L}* *400 HZ*	
10. Check for sine wave and that multimeter reading is between 8.1770 and 8.5108. 11. Connect oscilloscope and RMS multimeter to RSS terminals S1 (LO) and S3 (HI) and check or sine wave and that multimeter reading is between 8.1770 and 8.5108. 12. Adjust output of oscillator and power amplifier for 115 V_{RMS}, 400 HZ.			

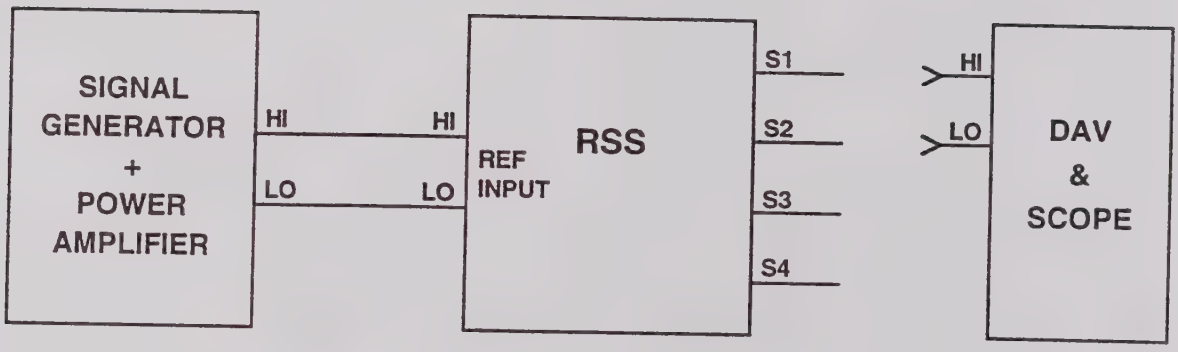


Figure 5-2. Test Setup, External Input/Output L-L Tests

Table 5-3. Performance Test

(Cont'd.)

ACTION	MAIN DISPLAY	VOLTAGE DISPLAY	NOTES
13. Set RSS to 26 V_{L-L}.	*RES* *45.0000 DEG* *EXT REF*	*26.0 V_{L-L}* *400 HZ*	
14. Check for sine wave and that multimeter reading is between 18.0171 and 18.7525.			
15. Connect oscilloscope and RMS multimeter to RSS terminals S4 (LO) and S2 (HI) and check for sine wave and that multimeter reading is between 18.0171 and 18.7525.			
16. Set RSS to 90 V_{L-L}.	*RES* *45.0000 DEG* *EXT REF*	*90.0 V_{L-L}* *400 HZ*	
17. Check for sine wave and that multimeter reading is between 62.3668 and 64.9124.			
18. Connect oscilloscope and RMS multimeter to RSS terminals S1 (LO) and S3 (HI) and check for sine wave and that multimeter reading is between 62.3668 and 64.9124.			
19. With power off, see figure 5-3 and connect test equipment as shown.			
20. Turn power on and set RSS to 4 V_{REF}, 400 HZ, INT REF.	*RES* *0.0000 DEG* *INT REF*	*4.00 V_{REF}* *400 Hz*	
21. Check that multimeter reading is between 3.88 and 4.12.			
22. Set RSS to 11.8 V_{REF}.	*RES* *0.0000 DEG* *INT REF*	*11.8 V_{REF}* *400 Hz*	
23. Check that multimeter reading is between 11.446 and 12.154.			

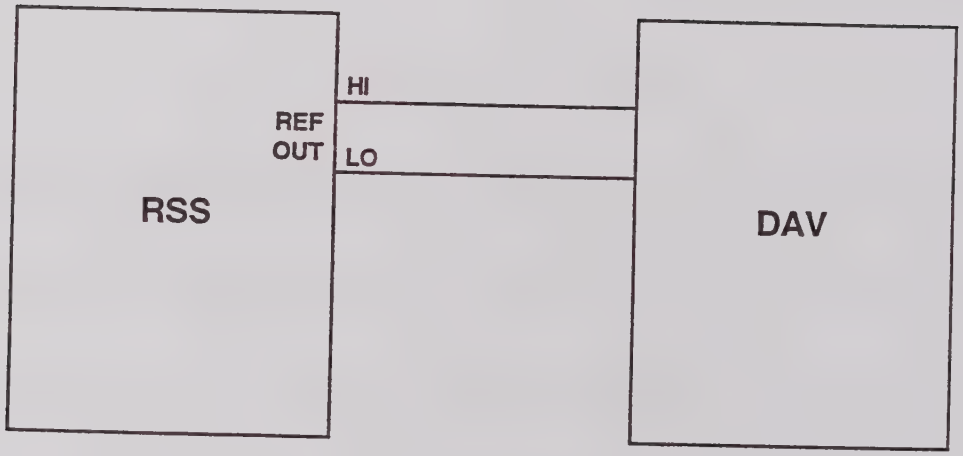


Figure 5-3. Test Setup, Internal Reference AC Voltage Tests

Table 5-3. Performance Test

(Cont'd.)

ACTION	MAIN DISPLAY	VOLTAGE DISPLAY	NOTES
24. Set RSS to 26 V_{REF}.	*RES* *0.0000 DEG* *INT REF*	*26 V_{REF}* *400 Hz*	
25. Check that multimeter reading is between 25.22 and 26.78.			
26. Set RSS to 115 V_{REF}.	*RES* *0.0000 DEG* *INT REF*	*115 V_{REF}* *400 Hz*	
27. Check that multimeter reading is between 111.55 and 118.45.			
28. With power off, see figure 5-4 and connect test equipment as shown.			
29. Turn power on and set RSS to 26 V_{REF}, 11.8 V_{L-L}, 45°, 400 HZ, Phase offset 0, RES, INT REF.	*RES* *45.0000 DEG* *INT REF*	*11.8 V_{L-L}* *400 Hz*	
Note: Data within brackets in following steps applies to step 56. Use unbracketed data for steps 33 through 49.			
30. Press ±180° PHASE push button on DAV and connect S1 of RSS to LO SIG terminal of DAV set to measure phase angle ± 180°. Connect S3 of RSS to HI SIG terminal of DAV and check that angle displayed on DAV is between -0.5°[-5°] and 0.5°[5°].			
31. Connect S4 of RSS to LO SIG terminal of DAV. Connect S2 of RSS to HI SIG terminal of DAV and check that angle displayed on DAV is between -0.5°[-5°] and 0.5°[5°].			
32. Set RSS phase offset to 45.			
33. Check that angle displayed on DAV is between 44.5°[40°] and 45.5°[50°].			

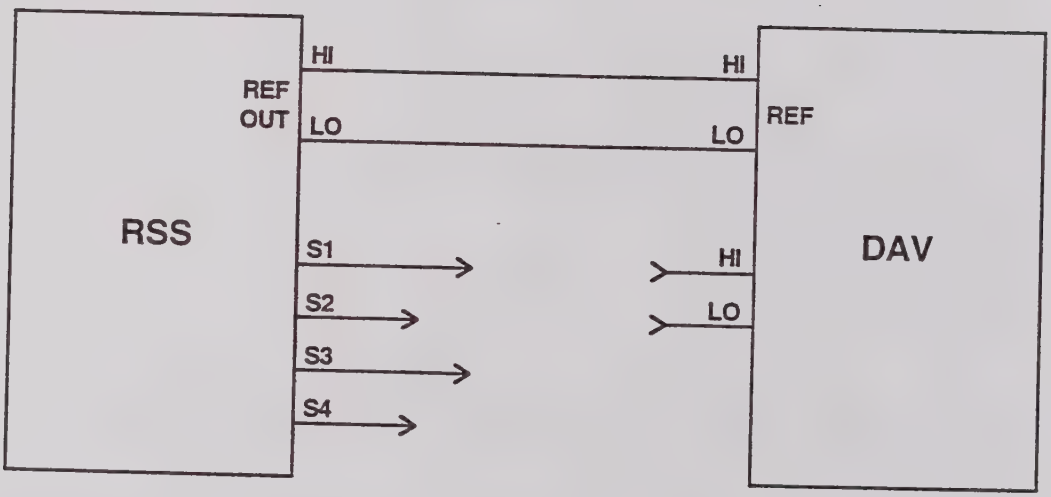


Figure 5-4. Test Setup, Phase Offset Tests

Table 5-3. Performance Test

(Cont'd.)

ACTION	MAIN DISPLAY	VOLTAGE DISPLAY	NOTES
34. Connect S1 of RSS to LO SIG terminal of DAV. Connect S3 of RSS to HI SIG terminal of DAV and check that angle displayed on DAV is between 44.5°[40°] and 45.5°[50°].			
35. Set RSS phase offset to 90.			
36. Check that angle displayed on DAV is between 89.5°[85°] and 90.5°[95°].			
37. Connect S4 of RSS to LO SIG terminal of DAV. Connect S2 of RSS to HI SIG terminal of DAV and check that angle displayed on DAV is between 89.5°[85°] and 90.5°[95°].			
38. Set RSS phase offset to 135.			
39. Check that angle displayed on DAV is between 134.5°[130°] and 135.5°[140°].			
40. Connect S1 of RSS to LO SIG terminal of DAV. Connect S3 of RSS to HI SIG terminal of DAV and check that angle displayed on DAV is between 134.5°[130°] and 135.5°[140°].			
41. Set RSS phase offset to 180.			
42. Check that angle displayed on DAV is between 179.5°[175°] and -179.5°[-175°].			
43. Connect S4 of RSS to LO SIG terminal of DAV. Connect S2 of RSS to HI SIG terminal of DAV and check that angle displayed on DAV is between 179.5°[175°] and -179.5°[-175°].			
44. Set RSS phase offset to -45°.			
45. Check that angle displayed on DAV is between -44.5°[-40°] and -44.5°[-50°].			
46. Connect S1 of RSS to LO SIG terminal of DAV. Connect S3 of RSS to HI SIG terminal of DAV and check that angle displayed on DAV is between -44.5°[-40°] and -45.5°[-50°].			
47. Set RSS phase offset to -90°.			
48. Check that angle displayed on DAV is between -90.5°[-95°] and -89.5°[-85°].			
49. Connect S4 of RSS to LO SIG terminal of DAV. Connect S2 of RSS to HI SIG terminal of DAV and check that angle displayed on DAV is between -90.5°[-95°] and -89.5°[-85°].			
50. Set RSS phase offset to -135°.			
51. Check that angle displayed on DAV is between -134.5° and -135.5°.			
52. Connect S1 of RSS to LO SIG terminal of DAV. Connect S3 of RSS to HI SIG terminal of DAV and check that angle displayed on DAV is between -134.5° and -135.5°.			

Table 5-3. Performance Test

(Cont'd.)

	ACTION	MAIN DISPLAY	VOLTAGE DISPLAY	NOTES
53.	Set RSS to 26 V_{REF}, 26 V_{L-L}, 45°, 10 KHZ, RSS, INT REF.	*RES* *45.0000 DEG* *INT REF*	*26.0 V_{L-L}* *10 KHZ*	
54.	Check that angle displayed on DAV is between 310° and 320°.			
55.	Connect S4 of RSS to LO SIG terminal of DAV. Connect S2 of RSS to HI SIG terminal of DAV and check that angle displayed on DAV is between 310° and 320°.			
56.	Repeat steps 29 through 49, substituting data within brackets.			
57.	With power off, see figure 5-5 and connect test equipment as shown.			Begin DC offset tests.
58.	Turn power on and set RSS to 27 V_{L-L}, 0 V_{REF}, 0°, 400 HZ, INT REF.	*RES* *0.0000 DEG* *INT REF*	*27 V_{L-L}* *400 Hz*	
59.	Connect digital multimeter (DMM) HI and LO inputs to RSS REF OUT HI and LO terminals, respectively, and check that DMM reading is between -5 mV and +5 mV.			
60.	Connect DMM HI and LO inputs to RSS S3 and S1 terminals, respectively, and check that DMM reading is between -5 mV and + 5 mV.			
61.	Set RSS to 90°.	*RES* *90.0000 DEG* *INT REF*		
62.	Connect DMM HI and LO inputs to RSS S2 and S4 terminals, respectively, and check that DMM reading is between -5 mV and + 5 mV.			

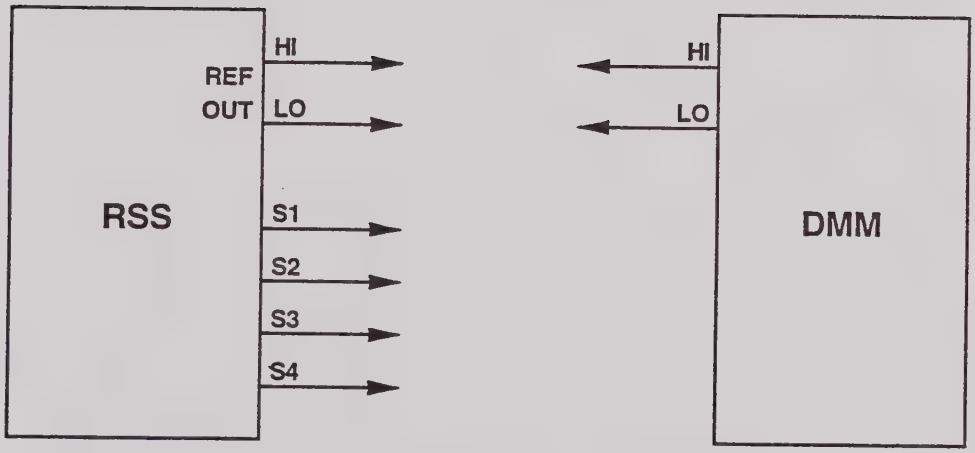


Figure 5-5. Test Setup, DC Offset Tests

Table 5-3. Performance Test

(Cont'd.)

Part 3. Accuracy Tests

1. With power off, see figure 5-6A and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).

   Note: If an overload occurs during the following tests, wait approximately 5 seconds before resetting the L-L voltage.

2. Turn power on and set RSS to 47 Hz, 115 V_{REF}, 90 V_{L-L}, INT REF, and SYN mode.

   Note: Calibration (CAL) is not permitted during an overload condition (OVLD and 0.0 V_{L-L} displayed) or if the line-to-line voltage is set to zero.

3. Press CAL push button. Wait for calibration to complete (approximately 12 seconds) before proceeding.

   Note: Steps 4 through 7 configure the DAV to read voltages that are in-phase with the reference.

4. Set ratio box to 0°.

5. Set RSS to 60°.

6. Press PHASE ANGLE push button on DAV.

7. Press PHASE OFFSET and ENTER push buttons on DAV.

8. Set RSS angle and ratio box setting to first value specified in following table for applicable test set-up.

9. Compare DAV in-phase reading to values listed in Test Limits column of table.

10. Repeat steps 8 and 9 for other angles listed under Test Set-Up.

11. With power off, see figure 5-6B and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).

12. Repeat steps 2 - 10.

13. With power off, see figure 5-6C and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).

14. Repeat steps 2 - 10.

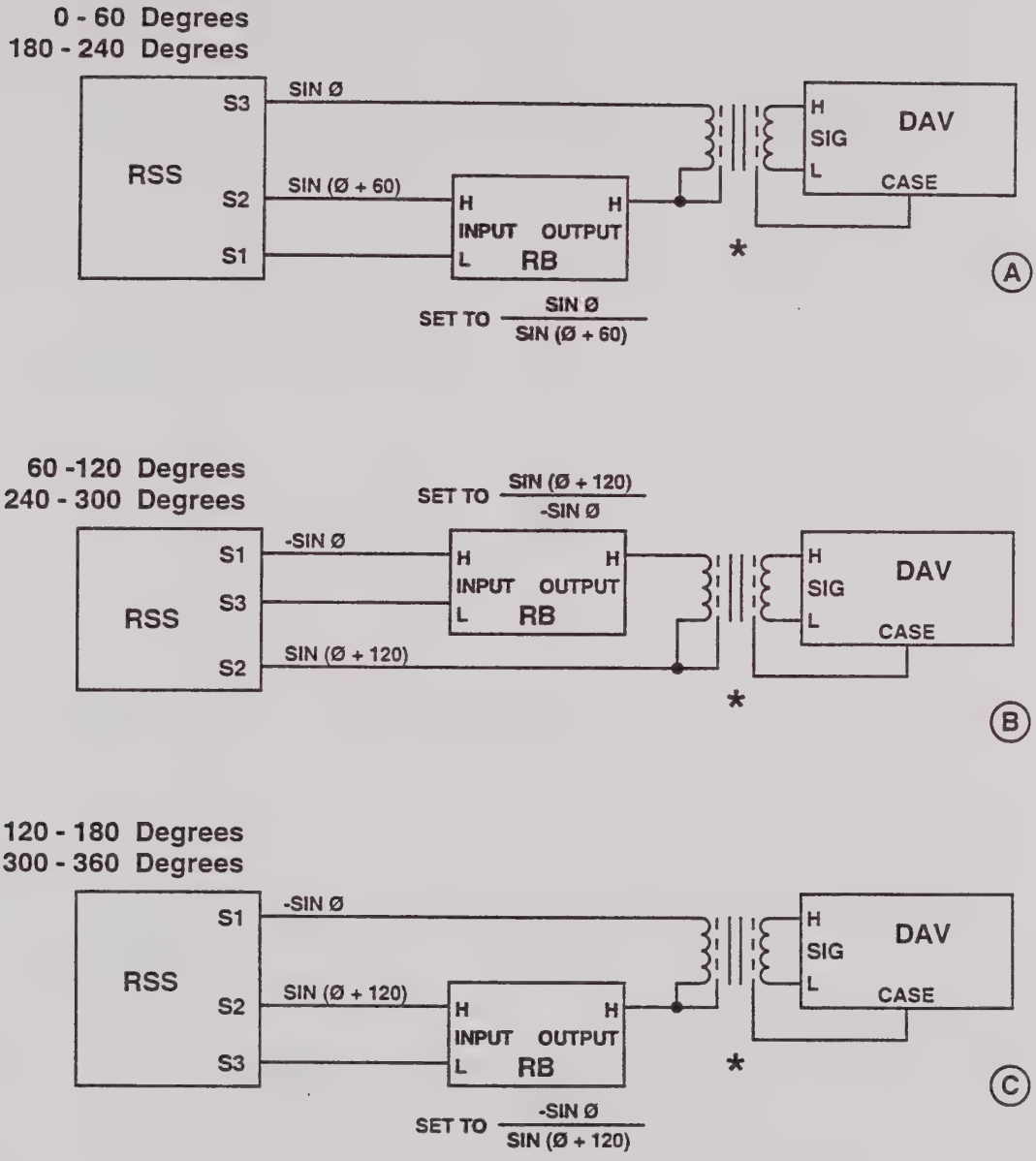
15. Press CLEAR VAR push button on DAV.

Table 5-3. Performance Test

(Cont'd.)

	TEST SET-UP	ANGLE	RATIO BOX SETTING	TEST LIMITS	DATA
47 HZ 115 V_{REF} 90 V_{L-L} INT REF SYN MODE	Figure 5-6A	0°	0.0000000	±1309 μV	
		22.5°	0.3859856	±1143 μV	
		45°	0.7320508	±1174 μV	
		202.5°	0.3859856	±1143 μV	
		225°	0.7320508	±1174 μV	
	Figure 5-6B	67.5°	0.1412805	±1227 μV	
		90°	0.5000000	±1134 μV	
		112.5°	0.8587195	±1227 μV	
		247.5°	0.1412805	±1227 μV	
		270°	0.5000000	±1134 μV	
		292.5°	0.8587195	±1227 μV	
	Figure 5-6C	135°	0.7320508	±1174 μV	
		157.5°	0.3859856	±1143 μV	
		180°	0.0000000	±1309 μV	
		315°	0.7320508	±1174 μV	
		337.5°	0.3859856	±1143 μV	

Note: If different angles are used, see figure 5-6 for test equipment set-up and formulas to calculate new ratio box settings. See figure 5-7 and calculate new test limits. If different frequencies are used (≥ 1 KHz), perform procedure in paragraph 5.7.2 to determine if bridging transformer is required in set-up. Perform steps 3 - 7 after changing angles and/or frequency to configure RSS and DAV.



* BRIDGING TRANSFORMER AND CASE CONNECTION REQUIRED FOR FREQUENCIES ≥ 1 kHz IF COMMON MODE REJECTION IS NOT ADEQUATE FOR THIS MEASUREMENT. REFER TO PARAGRAPH 5.7.2 FOR PROCEDURE TO MAKE THIS DETERMINATION.

Figure 5-6. Test Setup, Synchro Tests

$$\text{DAV TOLERABLE ERROR } (\mu V) = \left| \frac{\text{SIN } (\phi) \times \text{COS } (30)}{\text{SIN } (120 - \theta)} \right| \times 10^6 \times V_{L\text{-}L} \left\{ \begin{array}{c} 0 \leq \theta \leq 60 \\ 180 \leq \theta \leq 240 \end{array} \right\}$$

$$= \left| \frac{\text{SIN } (\phi) \times \text{COS } (30)}{\text{SIN } (\theta)} \right| \times 10^6 \times V_{L\text{-}L} \left\{ \begin{array}{c} 60 \leq \theta \leq 120 \\ 240 \leq \theta \leq 300 \end{array} \right\}$$

$$= \left| \frac{\text{SIN } (\phi) \times \text{COS } (30)}{\text{SIN } (60 - \theta)} \right| \times 10^6 \times V_{L\text{-}L} \left\{ \begin{array}{c} 120 \leq \theta \leq 180 \\ 300 \leq \theta \leq 360 \end{array} \right\}$$

θ = STATIC ANGLE (DEGREES)
ϕ = TOLERABLE ERROR (DEGREES)

Figure 5-7. Synchro Equations (A)

Table 5-3. Performance Test

(Cont'd.)

16. With power off, see figure 5-6A and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).

17. Turn power on and set RSS to 400 Hz, 26 V_{REF}, 11.8 V_{L-L}, INT REF, and SYN mode.

18. Press CAL push button. Wait for calibration to complete (approximately 12 seconds) before proceeding.

    Note: Steps 19 through 22 configure the DAV to read voltages that are in-phase with the reference.

19. Set ratio box to 0°.

20. Set RSS to 60°.

21. Press PHASE ANGLE push button on DAV.

22. Press PHASE OFFSET and ENTER push buttons on DAV.

23. Set RSS angle and ratio box setting to first value specified in following table for applicable test set-up.

24. Compare DAV reading to values listed in Test Limits column of table.

25. Repeat step 23 and 24 for other angles listed under Test Set-Up.

26. With power off, see figure 5-6B and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).

27. Repeat steps 17 - 25.

28. With power off, see figure 5-6C and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).

29. Repeat steps 17 - 25.

30. Press CLEAR VAR push button on DAV.

Table 5-3. Performance Test

(Cont'd.)

	TEST SET-UP	ANGLE	RATIO BOX SETTING	TEST LIMITS	DATA
400 HZ 26 V_{REF} 11.8 V_{L-L} INT REF SYN MODE	Figure 5-6A	0°	0.0000000	±114 μV	
		22.5°	0.3859856	±100 μV	
		45°	0.7320508	±103 μV	
		202.5°	0.3859856	±100 μV	
		225°	0.7320508	±103 μV	
	Figure 5-6B	67.5°	0.1412805	±107 μV	
		90°	0.5000000	±99 μV	
		112.5°	0.8587195	±107 μV	
		247.5°	0.1412805	±107 μV	
		270°	0.5000000	±99 μV	
		292.5°	0.8587195	±107 μV	
	Figure 5-6C	135°	0.7320508	±103 μV	
		157.5°	0.3859856	±100 μV	
		180°	0.0000000	±114 μV	
		315°	0.7320508	±103 μV	
		337.5°	0.3859856	±100 μV	

Note: If different angles are used, see figure 5-6 for test equipment set-up and formulas to calculate new ratio box settings. See figure 5-7 and calculate new test limits. If different frequencies are used ($\geq$ 1 KHz), perform procedure in paragraph 5.7.2 to determine if bridging transformer is required in set-up. Perform steps 18 - 22 after changing angles and/or frequency to configure RSS and DAV.

Table 5-3. Performance Test

(Cont'd.)

31. With power off, see figure 5-8A and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).

32. Turn power on and set RSS to 400 Hz, 26 V_{REF}, 26 V_{L-L}, INT REF, and RES mode.

33. Press CAL push button. Wait for calibration to complete (approximately 12 seconds) before proceeding.

    Note: Steps 34 through 37 configure the DAV to read voltages that are in-phase with the reference.

34. Set ratio box to 0°.

35. Set RSS to 60°.

36. Press PHASE ANGLE push button on DAV.

37. Press PHASE OFFSET and ENTER push buttons on DAV.

38. Set RSS angle and ratio box setting to first value specified in following table for applicable test set-up.

39. Compare DAV reading of DAV to values listed in Test Limits column of table.

40. Repeat steps 38 and 39 for other angles listed under Test Set-Up.

41. With power off, see figure 5-8B and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).

42. Repeat steps 32 - 40.

43. With power off, see figure 5-8C and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).

44. Repeat steps 32 - 40.

45. With power off, see figure 5-8D and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).

46. Repeat steps 32 - 40.

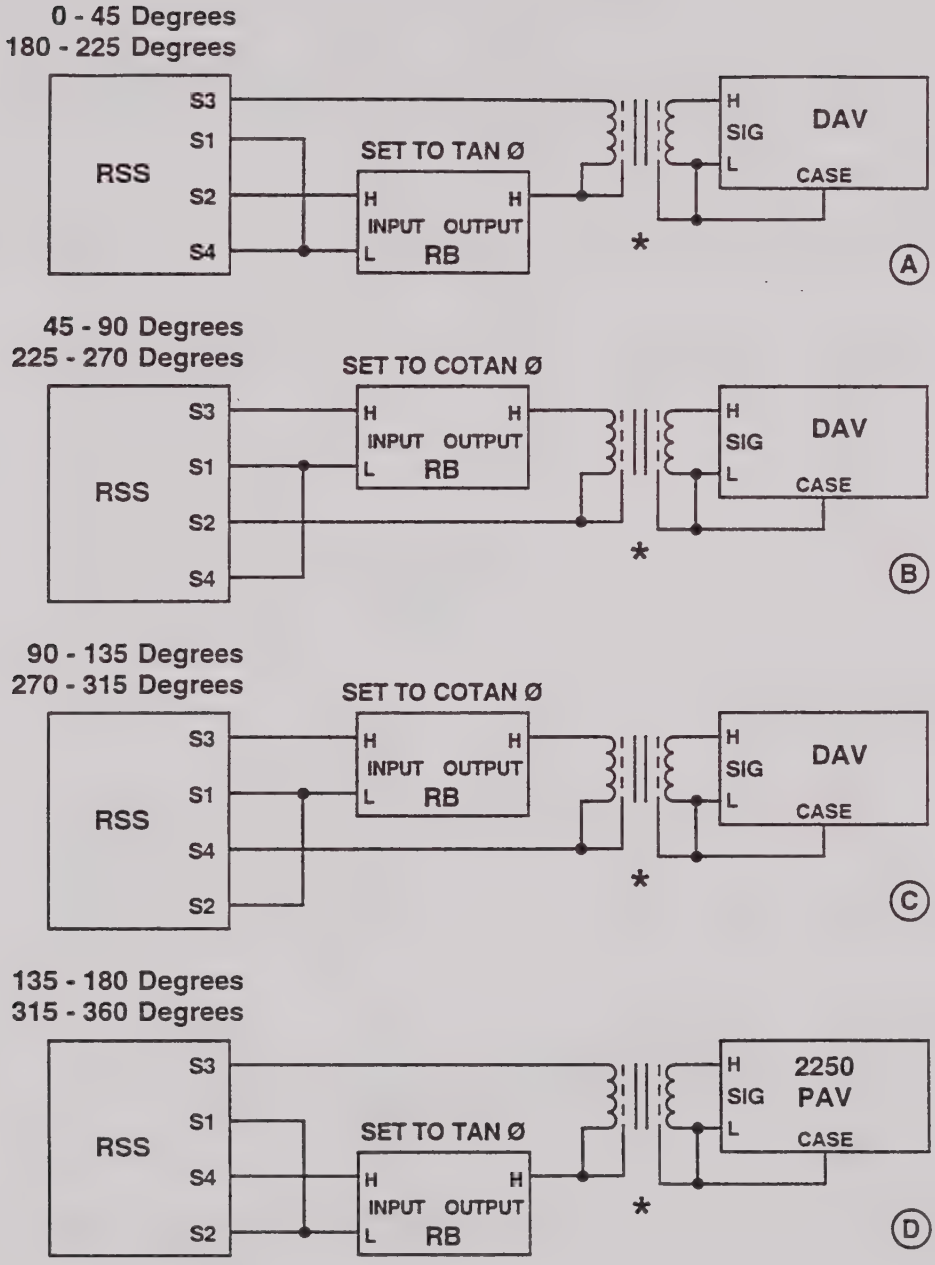
47. Press CLEAR VAR push button on DAV.

Table 5-3. Performance Test

(Cont'd.)

	TEST SET-UP	ANGLE	RATIO BOX SETTING	TEST LIMITS	DATA
400 HZ 26 V_{REF} 26 V_{L-L} INT REF RES MODE	Figure 5-8A	0°	0.0000000	±252 μV	
		22.5°	0.4142136	±273 μV	
		180°	0.0000000	±252 μV	
		202.5°	0.4142136	±273 μV	
	Figure 5-8B	45°	1.0000000	±357 μV	
		67.5°	0.4142136	±273 μV	
		225°	1.0000000	±357 μV	
		247.5°	0.4142136	±273 μV	
	Figure 5-8C	90°	0.0000000	±252 μV	
		112.5°	0.4142136	±273 μV	
		270°	0.0000000	±252 μV	
		292.5°	0.4142136	±273 μV	
	Figure 5-8D	135°	1.0000000	±357 μV	
		157.5°	0.4142136	±273 μV	
		315°	1.0000000	±357 μV	
		337.5°	0.4142136	±273 μV	

Note: If different angles are used, see figure 5-8 for test equipment set-up and formulas to calculate new ratio box settings. See figure 5-9 and calculate new test limits. If different frequencies are used (≥ 1 KHz), perform procedure in paragraph 5.7.2 to determine if bridging transformer is required in set-up. Perform steps 33 - 37 after changing angles and/or frequency to configure RSS and DAV.



* BRIDGING TRANSFORMER AND CASE CONNECTION REQUIRED FOR FREQUENCIES ≥ 1 KHz IF COMMON MODE REJECTION IS NOT ADEQUATE FOR MEASUREMENT. REFER TO PARAGRAPH 5.7.2 FOR PROCEDURE TO MAKE THIS DETERMINATION.

Figure 5-8. Test Setup for Resolver

$$\text{DAV TOLERABLE ERROR } (\mu V) = \left\{ \begin{array}{l} \pm 10^6 \times \left| \dfrac{\text{SIN } (\phi)}{\text{COS } (\theta)} \right| \times V_{L\text{-}L} \left\{ \begin{array}{l} -45^\circ \le \theta \le 45^\circ \\ 135^\circ \le \theta \le 225^\circ \end{array} \right. \\ \\ \pm 10^6 \times \left| \dfrac{\text{SIN } (\phi)}{\text{SIN } (\theta)} \right| \times V_{L\text{-}L} \left\{ \begin{array}{l} 45^\circ \le \theta \le 135^\circ \\ 225^\circ \le \theta \le 315^\circ \end{array} \right. \end{array} \right\}$$

WHERE:

θ = STATIC ANGLE (DEGREES)

ϕ = TOLERABLE ERROR (DEGREES)

Figure 5-9. Resolver Equations (A)

Table 5-3. Performance Test

(Cont'd.)

48. With power off, see figure 5-8A and connect RSS to test equipment. See paragraph 5.7.2 and perform procedure to determine if bridging transformer is required.

49. Turn power on and set RSS to 10 KHz, 26 V_{REF}, 11.8 V_{L-L}, INT REF, and RES mode.

50. Press CAL push button. Wait for calibration to complete (approximately 12 seconds) before proceeding.

    Note: Steps 51 through 54 configure the DAV to read voltages that are in-phase with the reference.

51. Set ratio box to 0°.

52. Set RSS to 60°.

53. Press PHASE ANGLE push button on DAV.

54. Press PHASE OFFSET and ENTER push buttons on DAV.

55. Set RSS angle and ratio box setting to first value specified in following table for applicable test set-up.

56. Compare reading of DAV to values listed in Test Limits column of table.

57. Repeat steps 55 and 56 for other angles listed under Test Set-Up.

58. With power off, see figure 5-8B and connect RSS to test equipment. Use bridging transformer if required - step 48).

59. Repeat steps 49 - 57.

60. With power off, see figure 5-8C and connect RSS to test equipment. Use bridging transformer if required - step 48).

61. Repeat steps 49 - 57.

62. With power off, see figure 5-8D and connect RSS to test equipment. Use bridging transformer if required - step 48).

63. Repeat steps 49 - 57.

64. Press CLEAR VAR push button on DAV.

Table 5-3. Performance Test

(Cont'd.)

	TEST SET-UP	ANGLE	RATIO BOX SETTING	TEST LIMITS	DATA
10 KHZ 26 V_{REF} 11.8 V_{L-L} INT REF RES MODE	Figure 5-8A	0°	0.0000000	±858 μV	
		22.5°	0.4142136	±929 μV	
		180°	0.0000000	±858 μV	
		202.5°	0.4142136	±929 μV	
	Figure 5-8B	45°	1.0000000	±1214 μV	
		67.5°	0.4142136	±929 μV	
		225°	1.0000000	±1214 μV	
		247.5°	0.4142136	±1214 μV	
	Figure 5-8C	90°	0.0000000	±858 μV	
		112.5°	0.4142136	±929 μV	
		270°	0.0000000	±858 μV	
		292.5°	0.4142136	±929 μV	
	Figure 5-8D	135°	1.0000000	±1214 μV	
		157.5°	0.4142136	±929 μV	
		315°	1.0000000	±1214 μV	
		337.5°	0.4142136	±929 μV	

Note: If different angles are used, see figure 5-8 for test equipment set-up and formulas to calculate new ratio box settings. See figure 5-9 and calculate new test limits. If different frequencies are used (≥ 1 KHz), see paragraph 5.7.2 and perform procedure to determine if bridging transformer is required in set-up. Perform steps 50 - 54 after changing angles and/or frequency to configure RSS and DAV.

Table 5-3. Performance Test

(Cont'd.)

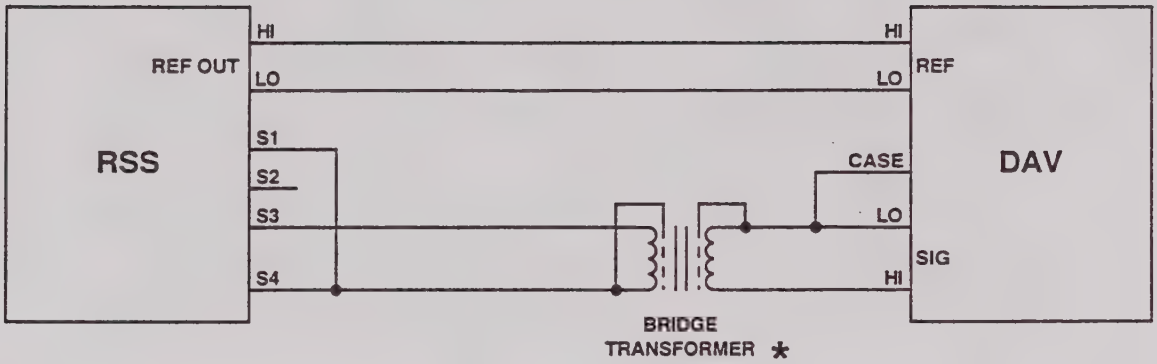
Part 4. Accuracy Tests if Ratio Box not available	
1.	With power off, see figure 5-10A and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).
2.	Turn power on and set RSS to 47 Hz, 115 V_{REF}, 90 V_{L-L}, INT REF, and SYN mode.
3.	Press CAL push button. Wait for calibration to complete (approximately 12 seconds) before proceeding.
4.	Set RSS angle to first angle listed in following table for applicable test set-up.
5.	Compare DAV reading to value listed in applicable Test Limits column of table.
6.	Set RSS angle to second angle listed in following table for applicable test set-up and repeat step 5.
7.	With power off, see figure 5-10B and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).
8.	Repeat steps 2 - 6.
9.	With power off, see figure 5-10 C and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).
10.	Repeat steps 2 - 6.
11.	With power off, see figure 5-10A and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).
12.	Turn power on and set RSS to 400 Hz, 26 V_{REF}, 11.8 V_{L-L}, INT REF, and SYN mode.
13.	Repeat steps 3 - 10.

Table 5-3. Performance Test

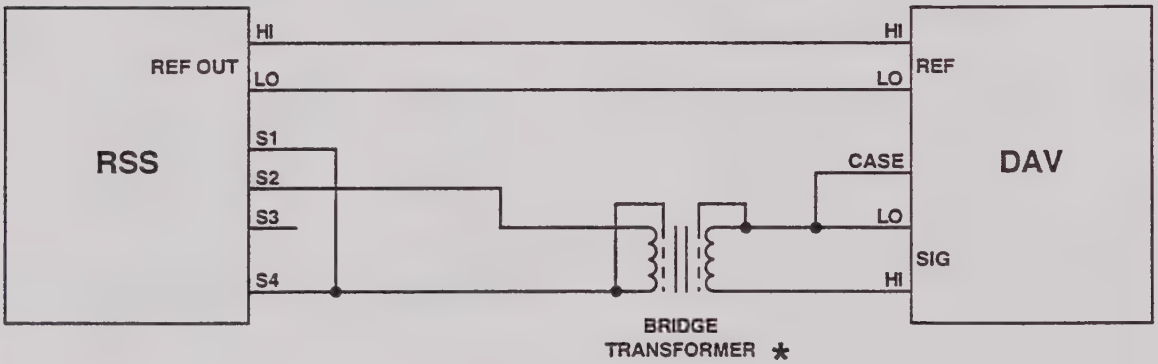
(Cont'd.)

	TEST SET-UP	ANGLE	TEST LIMITS	DATA
47 HZ 115 V_{REF} 90 V_{L-L} INT REF SYN MODE	Figure 5-10A	0°	±1309 μV	
		180°	±1309 μV	
	Figure 5-10B	120°	±1309 μV	
		300°	±1309 μV	
	Figure 5-10C	60°	±1309 μV	
		240°	±1309 μV	
400 HZ 26 V_{REF} 11.8 V_{L-L} INT REF SYN MODE	Figure 5-10A	0°	±114 μV	
		180°	±114 μV	
	Figure 5-10B	120°	±114 μV	
		300°	±114 μV	
	Figure 5-10C	60°	±114 μV	
		240°	±114 μV	

Note: If different angles are used, see figure 5-11 and calculate new test limits.



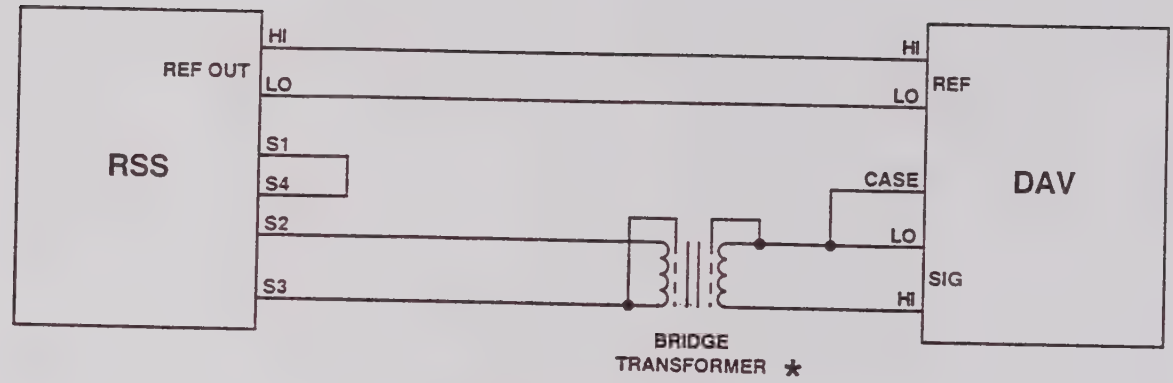
Resolver & Synchro 0° & 180°



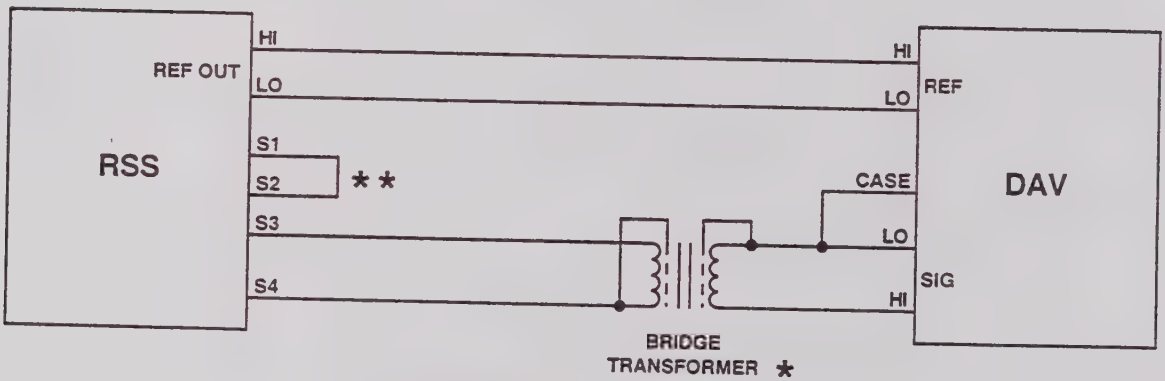
Resolver 90° & 270°
Synchro 120° & 300°

* BRIDGING TRANSFORMER AND CASE CONNECTION REQUIRED FOR FREQUENCIES ≥ 1 KHz IF COMMON MODE REJECTION IS NOT ADEQUATE FOR MEASUREMENT. REFER TO PARAGRAPH 5.7.2 FOR PROCEDURE TO MAKE THIS DETERMINATION.

Figure 5-10. Test Setup, Static Angular Tests (Sheet 1 of 2)



Resolver 45° & 225°
Synchro 60° & 240°



Resolver Only 135° & 315°

* BRIDGING TRANSFORMER AND CASE CONNECTION REQUIRED FOR FREQUENCIES ≥ 1 KHz IF COMMON MODE REJECTION IS NOT ADEQUATE FOR MEASUREMENT. REFER TO PARAGRAPH 5.7.2 FOR PROCEDURE TO MAKE THIS DETERMINATION.

** DO NOT CONNECT SHORTING JUMPER BETWEEN S1 & S2 IN SYNCHRO MODE.

Figure 5-10. Test Setup, Static Angular Tests (Sheet 2 of 2)

Table 5-3. Performance Test

(Cont'd.)

14.	With power off, see figure 5-10A and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).
15.	Turn power on and set RSS to 400 Hz, 26 V_{REF}, 26 V_{L-L}, INT REF, and RES mode.
16.	Press CAL push button. Wait for calibration to complete (approximately 12 seconds) before proceeding.
17.	Set RSS angle to first angle listed in following table for applicable test set-up.
18.	Compare DAV reading to value listed in applicable Test Limits column of table.
19.	Set RSS angle to second angle listed in following table for applicable test set-up and repeat step 18.
20.	With power off, see figure 5-10B and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).
21.	Repeat steps 15 - 19.
22.	With power off, see figure 5-10C and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).
23.	Repeat steps 15 - 19.
24.	With power off, see figure 5-10D and connect RSS to test equipment (bridging transformer not required; connect RSS and ratio box outputs directly to DAV).
25.	Repeat steps 15 - 19.
26.	With power off, see figure 5-10A and connect RSS to test equipment. See paragraph 5.7.2 and perform procedure to determine if bridging transformer is required.
27.	Turn power on and set RSS to 10 KHz, 26 V_{REF}, 11.8 V_{L-L}, INT REF, and RES mode.
28.	Repeat steps 16 - 25. Disregard note concerning bridging transformer if transformer is required - step 26.

Table 5-3. Performance Test

(Cont'd.)

	TEST SET-UP	ANGLE	TEST LIMITS	DATA
400 HZ 26 V_{REF} 26 V_{L-L} INT REF RES MODE	Figure 5-10A	0°	±252 μV	
		180°	±252 μV	
	Figure 5-10B	90°	±252 μV	
		270°	±252 μV	
	Figure 5-10C	45°	±359 μV	
		225°	±359 μV	
	Figure 5-10D	135°	±359 μV	
		315°	±359 μV	
10 KHZ 26 V_{REF} 11.8 V_{L-L} INT REF RES MODE	Figure 5-10A	0°	±858 μV	
		180°	±858 μV	
	Figure 5-10B	90°	±858 μV	
		270°	±858 μV	
	Figure 5-10C	45°	±1221 μV	
		225°	±1221 μV	
	Figure 5-10D	135°	±1221 μV	
		315°	±1221 μV	

Note: If different angles are used, see figure 5-12 and calculate new test limits.

SYNCHRO:

1) 0°, 120°, 180° & 300°

$$\beta\ (\mu V) = \pm 17{,}460 \times V_{L\text{-}L} \times \text{SPECIFICATION ANGULAR ACCURACY (DEGREES)}$$

2) 60° & 240°

$$\beta\ (\mu V) = \pm 17{,}460 \times V_{L\text{-}L} \times \text{SPECIFICATION ANGULAR ACCURACY (DEGREES)}$$

β = TOLERABLE IN-PHASE VOLTAGE MEASUREMENT

Figure 5-11. Synchro Equations

RESOLVER:

1) 0°, 90°, 180° & 270°

$$\beta\ (\mu V) = \pm 17{,}460 \times V_{L\text{-}L} \times \text{SPECIFICATION ANGULAR ACCURACY (DEGREES)}$$

2) 45°, 135°, 225° & 315°

$$\beta\ (\mu V) = \pm 24{,}840 \times V_{L\text{-}L} \times \text{SPECIFICATION ANGULAR ACCURACY (DEGREES)}$$

Figure 5-12. Resolver Equations

5.7.2 COMMON MODE REJECTION MEASUREMENTS

To determine if a bridging transformer is required for the test set-ups, perform the following procedure to measure the common mode rejection of the DAV:

1. Apply a signal between REF HI and LO/GUARD terminals of the DAV having amplitude and frequency characteristics equal to the line-to-line voltage and frequency of measurement specified in the RSS set-up.

2. Short-circuit the DAV SIG HI and LO/GUARD terminals with a test lead.

3. Apply same signal as in step 1 between SIG HI and CASE terminals.

4. Record in-phase and quadrature voltages displayed on 20 mV and 200 mV ranges of DAV, respectively.

5. Compute in-phase voltage using following formula: In-phase voltage = 0.2 x RSS tolerable error (See figure 5-7 or figure 5-9).

6. Compute quadrature voltage using following formula:

Quadrature voltage = 4 x RSS tolerable error (See figure 5-7 or figure 5-9).

7. Compare computed data with applicable data recorded in step 4. Use bridging transformer in test set-ups if measured data exceeds computed data.

5.8 ERROR CODE MESSAGES

The RSS tests its circuits during power-up, calibration, and remote modes. If an error is detected (table 3-6), an error code is shown in the RSS main display or sent over the interface. If an error code is displayed, refer the RSS to a higher level of maintenance for disposition.

GLOSSARY

Term	*Definition*
A	Assembly
A	Ampere
b	Blank
AC	Alternating current
AMPL	Amplitude
API	Angle position indicator
ATE	Automatic test equipment
C	Centigrade
CAL	Calibrate
CAP	Capacitor
CASS	Consolidated automatic support system
COS	Cosine
CW	Clockwise
CCW	Counter clockwise
CHAPT.	Chapter
cr	Carriage return
DC	Direct current
DEG	Degree
dp	Decimal point character
DSP	Digital signal processing
EEPROM	Electrically erasable programmable read only memory
EPROM	Erasable programmable read only memory
ERR	Error
ESD	Electrostatic sensitive discharge
EXT	External
FPGA	Field programmable gate array
FREQ	Frequency
H	Height
HZ	Hertz
I/O	Input/output
IEEE	Institute of Electrical, Electronic Engineers
INCR	Increment
INT	Internal
ISO	Isolated
KHZ	Kilohertz
L-L	Line-to-line
LED	Light emitting diode
lf	Line feed
LSB	Least significant bit
MA	milliampere
MIL	Military
MDAC	Multiplying digital-analog converter
MOD	Modulation
MSB	Most significant bit
MUX	Multiplexer
MV	Millivolt
NAI	North Atlantic Industries, Inc.
P	Page
P-P	Peak-to-peak
PGM	Program
PP	Pages
RAM	Random access memory
REF	Reference
REF DES	Reference designation
REM	Remote
RES	Resolver
RMS	Root-mean-square

GLOSSARY (Cont'd.)

Term	*Definition*
ROM	Read only memory
RPS	Revolutions per second
RSS	Resolver/synchro standard
RST	Reset
SCPI	Standard commands for programmable instruments
SIM	Simulate
SIN	Sine
SRQ	Service request
SYN	Synchro
TST	Test
V	Volt; Velocity
VAC	Volts, alternating current
VDC	Volts, direct current
VEL	Velocity
vs	Versus
W	Width

WARRANTY

A. The seller warrants products against defects in material and workmanship for one year from the date of original shipment. The seller's liability is limited to the repair or replacement of products which prove to be defective during the warranty period. There is no charge under the warranty except for transportation charges. The purchaser shall be responsible for products shipped until received by the seller.

B. The seller specifically excludes from the warranty 1) calibration, 2) fuses, and 3) normal mechanical wear, e.g.: end-of-life on assemblies such as switches, relays, gear trains, etc. is dependent upon number of operations or hours of use, and end-of-life may occur within the warranty period.

C. The seller is not liable for consequential damages or for any injury or damage to persons or property resulting from the operation or application of products.

D. The warranty is voided if there is evidence that products have been operated beyond their design range, improperly installed, improperly maintained or physically mistreated.

E. The seller reserves the right to make changes and improvements to products without any liability for incorporating such changes or improvements in any products previously sold, or for any notification to the purchaser prior to shipment. In the event the purchaser should require subsequently manufactured lots to be identical to those covered by this quotation, the seller will, upon written request, provide a quotation upon a change control program.

F. No other warranty expressed or implied is offered by the seller other than the forgoing.

CLAIMS FOR DAMAGE IN SHIPMENT

The purchaser should inspect and functionally test the product(s) in accordance with the instruction manual as soon as it is received. If the product is damaged in any way, including concealed damage, a claim should be filed immediately with the carrier, or if insured separately, with the purchaser's insurance company.

SHIPPING

On products to be returned under warranty, await receipt of shipping instructions then forward the instrument prepaid to the destination indicated. The original shipping container with their appropriate blocking and isolating material is the preferred method of packaging. Any other suitable strong container may be used providing the product is wrapped in a sealed plastic bag and surrounded with at least four inches of shock absorbing material to cushion firmly, preventing movement inside the container.

DECLARATION OF CONFORMITY

We **NORTH ATLANTIC INSTRUMENTS, INC.**
170 WILBUR PL.
BOHEMIA, NY 11716-2416

declare under our sole responsibility that the product

5300 SERIES SYNCHRO/RESOLVER

to which this declaration relates is in conformity with the following standard(s) or other normative document(s):

EN 50081-1: 1992 EN 55022; CONDUCTED EMISSIONS
EN 55022; RADIATED EMISSIONS

EN 50082-1: 1992 IEC 801-2; 1984 ESD
IEC 801-3; 1984 RADIATED IMMUNITY
IEC 801-4; 1988 EFT BURST

EN 61010-1: 1993/A2: 1995 SAFETY

following the provisions of COUNCIL DIRECTIVE 89/336/EEC
73/23/EEC

Place Bohemia, NY, U.S.A.

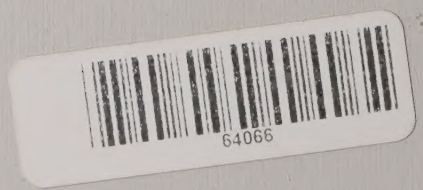
Date 1-31-97

(Signature)

Daniel A. Palladino
(Full Name)

Quality Manager
(Position)

FORM004.B



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